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Vegetable Investigations Under Dry-Land Conditions at Mandan, N. Dak.

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VEGETABLES have been grown experimentally under dry-land conditions since 1913 at the United States Northern Great Plains Field Station, near Mandan, N. Dak., in the eastern part of the northern Great Plains. Variety and cultural-method tests have been in progress and a demonstration 1-acre garden based on a rotation system

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was grown from 1920 to 1945. This circular is principally intended to give the results obtained from growing different kinds of vegetables in the acre garden over this period of 26 years and some general recommendations for growing vegetables in the northern Great Plains, such recommendations being based on experimental work at the Northern Great Plains Field Station.[1]

CLIMATE

The climate of the northern Great Plains has been classed as semiarid, although variable from year to year in both amount and distribution of the annual and seasonal precipitation. There are comparatively heavy rains in late spring and early summer and light ones in the fall and winter. Normally about half of the annual precipitation comes in May, June, and July, and the seasonal precipitation from April 1 to September 30 is about three-fourths of the annual.

The monthly, the seasonal, and the annual precipitation at the Northern Great Plains Field Station for 1920–45 are given in table 1. The seasonal precipitation, upon which garden crops are largely dependent, ranged from a low of 2.96 inches in the drought year 1936 to 16.86 inches in 1941, with a mean of 11.97 inches for the 26-year period. The mean annual precipitation for the same period was 15.44 inches, which compares with a mean of 16.56 inches for the 74-year period 1875–1948.[2] The 2 years with the lowest annual precipitation for the entire 74-year period (8.13 inches in 1934 and 6.43 inches in 1936) came while the acre garden was in operation.

The seasonal evaporation (April 1 to September 30) from a free water surface was high, especially in dry years. This figure at Mandan ranged from 25.04 inches in 1942 to 47.26 inches in 1936, the mean for the period 1920–45 being 33.29 inches.

High winds, especially hot summer winds, are often very trying to garden crops, and protection from wind is important for successful gardening. The months having the highest average wind velocity are March, April, and May, with means of 6.8, 7.3, and 6.8 miles per hour, respectively, for the 26-year period. The average annual mean wind velocity taken near the ground is 5.7 miles per hour.

At Mandan summer temperatures as high as 115° F., and winter temperatures as low as −46° were recorded. The low winter temperatures limit the growing of perennial vegetables to the hardiest kinds. Average mean monthly temperatures for 1920–45 ranged from 9.6° for January to 71.8° for July; the average annual mean was 41.8°.

Dates of the last killing frost in the spring and of the first in the fall at Mandan, together with the number of days in the frost-free periods, for 1920–45 are given in table 2. Killing frosts occurred as late as May 24, and as early as September 9, the average frost-free period lasting from May 9 to September 23, or 136 days. Frost injury frequently occurred both in the spring and in the fall.

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[1] The work was under the direction of the old Division of Dry Land Agriculture until July 1, 1945, when it was transferred to the Division of Fruit and Vegetable Crops and Diseases.

[2] Obtained from records of United States Weather Bureau, Bismarck, N. Dak., for 1875–1913, and from records taken at the Northern Great Plains Field Station for 1914–48.

TABLE 1.—*Monthly, seasonal, and annual precipitation at the Northern Great Plains Field Station, Mandan, N. Dak., 1920–45*

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Seasonal (Apr.–Sept.)	Annual
	In.	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*
1920	0.52	0.20	1.21	0.58	1.72	1.85	2.68	1.81	1.29	0.25	0.37	0.21	9.93	12.69
1921	.18	.09	.79	2.59	3.05	.82	3.38	.25	1.58	1.39	.87	.24	11.67	15.23
1922	.28	1.55	.52	.66	2.05	3.43	3.17	.32	2.31	.64	1.60	.82	11.94	17.35
1923	.36	.38	.16	1.85	1.18	1.94	4.12	1.15	2.31	.54	.28	.14	12.55	14.41
1924	.03	.25	.28	1.68	.41	5.56	2.07	2.35	1.34	1.94	.06	.28	13.41	16.25
1925	.28	.03	.44	.94	1.18	7.34	.33	1.31	.99	.69	.15	.38	12.09	14.06
1926	.71	.22	.04	.13	2.41	1.20	2.19	1.31	2.38	.18	.30	.44	9.62	11.51
1927	.18	.14	1.17	1.37	6.65	2.00	2.37	3.16	.49	.44	1.56	.77	16.04	20.30
1928	.20	.07	.23	.99	.55	6.32	4.94	2.24	.89	.19	.06	.17	15.93	16.85
1929	.80	.31	1.47	1.75	2.68	.99	1.20	.81	1.56	1.81	.14	.70	8.99	14.22
1930	.19	1.68	(1)	1.71	2.23	1.50	2.40	2.00	2.56	1.85	1.13	.13	12.40	17.38
1931	.05	.44	1.62	.43	2.14	1.65	4.32	1.01	3.11	1.46	.47	.74	12.66	17.44
1932	.44	.19	1.00	1.99	3.48	3.33	1.90	.70	.24	2.12	.19	.18	11.64	15.76
1933	1.23	.34	1.02	.86	1.83	2.18	1.80	.41	.27	.55	.90	.52	7.35	11.91
1934	.06	.05	.58	.63	.17	3.78	1.10	.25	.47	.73	.17	.14	6.40	8.13
1935	.13	.36	1.13	3.09	2.63	2.85	4.71	1.34	.22	(1)	.96	.88	14.84	18.30
1936	.61	.72	1.12	.48	.04	.43	.00	.55	1.46	.17	.61	.24	2.96	6.43
1937	.86	.49	.48	1.38	1.29	5.65	1.83	1.34	1.37	.43	.34	.63	12.86	16.09
1938	.54	1.06	.64	.97	2.42	3.11	2.90	.72	1.25	.21	1.04	.18	11.37	15.04
1939	.67	.62	.44	.74	1.93	4.65	1.69	2.19	.17	.54	(1)	.31	11.37	13.95
1940	.03	.45	.93	4.24	1.20	1.95	2.73	.25	1.28	1.69	.98	.41	11.65	16.14
1941	.31	.22	1.00	1.57	1.95	5.72	1.10	2.36	4.16	.90	.27	.16	16.86	19.72
1942	(1)	.47	.79	3.15	2.30	2.44	3.10	1.30	2.33	.69	.04	.46	14.62	17.07
1943	1.17	.55	1.67	.87	1.95	7.67	1.56	3.20	.16	1.56	.60	.19	15.41	21.15
1944	.26	.49	.27	1.22	3.13	5.54	.67	3.19	1.17	.07	3.44	.01	14.92	19.46
1945	.60	.25	1.01	1.02	1.54	1.78	1.94	3.48	1.85	.04	.53	.61	11.61	14.65
Mean	.41	.45	.77	1.42	2.00	3.30	2.32	1.50	1.43	.81	.66	.38	11.97	15.44

[1] Trace.

TABLE 2.—*Dates of last spring frost and first fall frost, minimum temperatures on those dates, and frost-free period, Northern Great Plains Field Station, Mandan, N. Dak., 1920–45*

Year	Last spring frost		First fall frost		Frost-free period
	Date	Minimum temperature	Date	Minimum temperature	
		° *F.*		° *F.*	*Days*
1920	Apr. 27	18	Sept. 28	28	153
1921	May 14	28	Sept. 30	31	138
1922	Apr. 25	29	Oct. 7	26	164
1923	May 14	29	Oct. 4	32	142
1924	May 24	23	Sept. 26	31	124
1925	May 16	27	Sept. 20	28	126
1926	May 12	32	Sept. 18	31	128
1927	May 10	28	Sept. 20	29	132
1928	May 2	31	Sept. 22	28	142
1929	May 19	28	Sept. 17	25	120
1930	May 16	26	Sept. 26	27	132
1931	May 20	31	Oct. 7	27	139
1932	Apr. 30	31	Sept. 21	30	143
1933	May 9	29	Sept. 25	30	138
1934	Apr. 26	28	Sept. 14	24	140
1935	Apr. 29	30	Sept. 25	28	148
1936	Apr. 28	18	Sept. 26	29	150
1937	May 12	25	Sept. 16	31	126
1938	May 8	28	Sept. 18	30	132
1939	May 10	29	Sept. 24	24	136
1940	May 14	29	Sept. 10	28	118
1941	May 8	28	Sept. 26	29	140
1942	May 16	31	Sept. 18	31	124
1943	May 12	27	Sept. 9	28	119
1944	May 4	17	Oct. 7	28	155
1945	May 13	26	Sept. 24	28	133
Average	May 9		Sept. 23		136

Some of the adverse climatic factors from the standpoint of successful gardening in the northern Great Plains are as follows:

1. Low annual precipitation and frequent periods of drought.
2. Strong drying winds, especially when combined with high temperatures.
3. Dry atmosphere and a high rate of summer evaporation.
4. Comparatively short frost-free period.
5. Occasional hail.

Although the dry-land gardener in the northern Great Plains must contend with the climatic hazards, not all climatic factors are adverse. Many plant diseases and insects are not so troublesome as in more humid regions, and the results over a long period demonstrate that gardening for home use is well worth while, especially if supplementary irrigation water is available in periods of drought.

THE ACRE GARDEN

The acre garden, based on a rotation system, was started in 1920 and continued through 1945. The plan of the garden was evolved by T. K. Killand,[3] who was responsible for its care until the time of his death in 1944 and published the results of the first 5 years' work.[4] The site chosen was comparatively level and protected by Siberian pea-tree hedges on the west and east sides. The soil was a sandy loam. The dimensions were 160 by 272 feet, an area of approximately 1 acre, which was ample to supply the needs of a family of five besides producing surpluses for sale in good years.[5] The 160-foot rows ran across the plot from north to south and, except in the case of onions, were spaced wide enough apart to permit horse or garden-tractor cultivation. The land was cultivated and hoed often enough to control weeds and to break up any hard crusts of soil that formed after heavy rains.

Vegetables were harvested when ready for the table or for storage. Yields were measured in quarts, pounds, or number of ears, according to the usual market practice for the different vegetables at Mandan in 1920.

The varieties used in the acre garden were considered the best standard varieties at the time the experiment was started. Most of them were planted in rows of uniform length throughout the history of the garden, but a few changes were made in varieties used and row lengths. When it seemed desirable to extend the season of certain vegetables, generally successional plantings of the same variety were made rather than plantings of an early and a late variety at the same time.

Plan and Rotation System

A planned 4-year rotation of garden crops was considered desirable because it provided (1) better control of insect pests and diseases; (2) better adaptation of the various crops to their fertility and moisture requirements; and (3) a permanent site for the garden that could be protected from wind by sheltering trees or hedges. The acre garden accordingly was divided into four plots of equal size, and the vegetables

[3] Formerly senior scientific aid, old Division of Dry Land Agriculture.

[4] Killand, T. K. dry-land gardening at the northern great plains field station, mandan, n. dak. U. S. Dept. Agr. Dept. Bul. 1427, 16 pp., illus. 1926.

[5] This area, on an average, produced far more than an ordinary family could consume, and smaller gardens may fulfill the vegetable needs on most farms.

grown were divided into four general types: Leaf crops, root crops, legume crops, and vine crops and potatoes. The rotation of the four different types of vegetables on the four plots was as follows:

Year:	Plot A	Plot B	Plot C	Plot D
First	Leaf crops.	Vine crops and potatoes.	Legume crops.	Root crops.
Second	Root crops.	Leaf crops.	Vine crops and potatoes.	Legume crops.
Third	Legume crops.	Root crops.	Leaf crops.	Vine crops and potatoes.
Fourth	Vine crops and potatoes.	Legume crops.	Root crops.	Leaf crops.

Since leaf crops were thought to be most in need of rich soil, the plot on which they were to be grown received a heavy application of well-rotted manure in the fall before planting. Cabbage, cauliflower, and sweet corn were planted in this plot. Although the last two are not leaf crops, they were included here to fill out the plot because of their similar soil requirements.

Root crops followed the leaf crops so that they would benefit somewhat from the manuring given the leaf-crop plot. These crops do not require planting on freshly manured land, which might lead to excessive leaf development and fibrous roots. Beets, carrots, rutabagas, parsnips, onions, tomatoes, eggplant, and peppers were used in this plot. The last four were included with the root crops because they were thought to thrive best under similar soil conditions.

Legume crops followed the root crops because they were not thought to be very exacting in soil-fertility requirements, are short-season crops for the most part, and would leave the land in good condition for the vine crops and potatoes that were to follow. Shell beans, bush snap beans, and peas were included in this plot.

Vine crops and potatoes followed the legume crops. Early potatoes, pumpkins, squashes, watermelons, muskmelons, and cucumbers were included in this plot.

Several vegetable crops adapted to the area were grown elsewhere on the station land and were not included in this experiment. These crops, however, could be included in a farm garden. Spinach and lettuce would be suitable for the leaf-crop plot, radishes and turnips for the root-crop plot, and perennials, such as asparagus, rhubarb, and horseradish, for one end of the garden where they would not interfere with the rotation.

Although the rotation system described appears to have been well planned and gave satisfactory results over a period of years, there is no evidence to indicate that it is either better or worse than other rotation systems. The vegetables in the four plots of the garden as they appeared in July 1924 are shown in figures 1 and 2.

Experimental Data

Statistics on the years the various vegetable crops were grown, the sizes and dates of the plantings, the spacing, the harvest dates, yields, and estimated values of the crop are shown in table 3. A graphic illustration of the average yields of the different crops on an acre basis

FIGURE 1.—*A*, Leaf-crop plot of the acre garden showing sweet corn, cauliflower, and cabbage, July 25, 1924; *B*, root-crop plot showing onions, parsnips, carrots, beets, rutabagas, and tomatoes on the same date.

is shown in figure 3. In calculating averages for the yields of the various crops in table 3 and elsewhere the average yields of all varieties grown in any given year were determined and the final average was the average of the averages for each year. In this way each year had an equal weight in the final average value. Years in which there was no stand for any planting or in which cutworms or rabbits destroyed the plants were figured in the averages as having zero yields in the different tables. However, years in which a variety was not planted, the data were lost, or the whole crop was stolen or destroyed by boys (for example, watermelons) were not figured in the averages.

FIGURE 2.—*A*, Legume-crop plot of the acre garden showing shell beans, wax beans, and peas, July 25, 1924; *B*, vine-crop plot showing cucumbers, melons, pumpkins, squashes, and early potatoes on the same date.

The average values of the crops, which were calculated from estimates of local grocerymen of prices they have paid farmers in recent years, are undoubtedly too high for the period as a whole and are somewhat high in comparison with prices that truck gardeners receive in truck-garden areas. They do indicate, however, what farmers received for surplus vegetables sold in local stores in the northern Great Plains and are of interest in comparing the different crops. The total average value per annum of all crops grown in the acre garden was $295.94 to the acre. Tomatoes show a higher average value than any other crop both per annum and on an acre basis. It should be noted however that tomato plants in this experiment were pruned and staked.

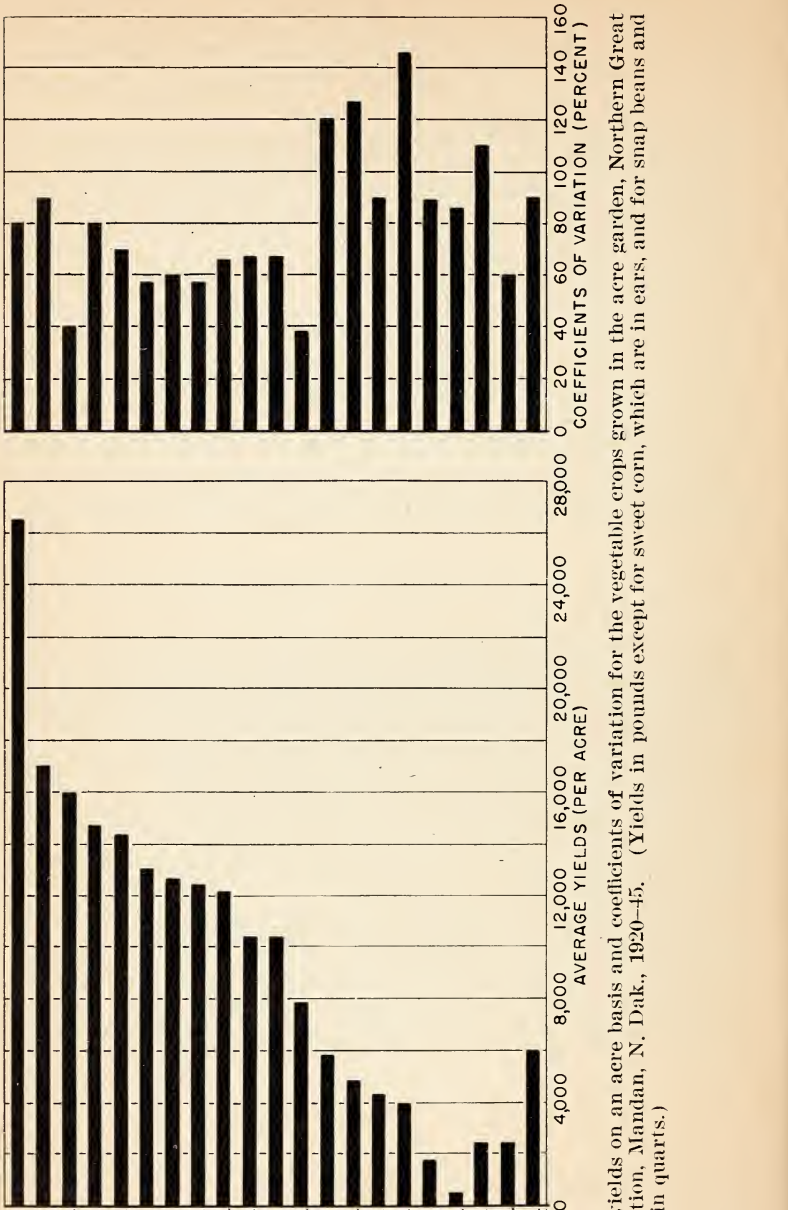

FIGURE 3.—Average yields on an acre basis and coefficients of variation for the vegetable crops grown in the acre garden, Northern Great Plains Field Station, Mandan, N. Dak., 1920–45. (Yields in pounds except for sweet corn, which are in ears, and for snap beans and peas, which are in quarts.)

TABLE 3.—*Planting, cultural, and harvesting data, yields, and value of crops grown in the acre garden, Northern Great Plains Field Station, Mandan, N. Dak., 1920–45*

Crop	Period grown	Average size of planting		Average planting date [1]		Spacing after thinning	Average harvest-period date [1]	Yield				Average crop value—	
		Combined row lengths	Hills	Greenhouse	Garden			Total for period	Yearly average	Yearly average per 100 feet of row or 10 hills	Yearly average on acre basis	Per annum	On acre basis
	Years	*Feet*	*Number*			*Inches*		*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Dollars*	*Dollars*
Beans, shell	25	1,369.6			May 13	36 by 3	Sept. 16	1,203	48.1	3.5	508.2	3.85	41
								Quarts	*Quarts*	*Quarts*	*Quarts*		
Beans, snap	26	1,280.0			May 9; May 28	36 by 5	July 20–Aug. 15; July 29–Aug. 18.	5,375	206.7	16.2	2,352.2	24.80	282
								Pounds	*Pounds*	*Pounds*	*Pounds*		
Beets	26	510.8			May 8; May 26	36 by 4	July 15–Sept. 13; Sept. 29	11,329	435.7	87.8	12,748.6	13.07	382
Cabbage	26	800.0		Mar. 16; Apr. 13	May 10; May 22	36 by 24	July 20–Aug. 22; Aug. 23–Sept. 27.	20,767	798.7	101.8	14,781.4	31.95	591
Carrots	26	473.8			Apr. 22; May 10; May 29.	36 by 2	Aug. 29; Sept. 24; Sept. 27.	12,351	475.0	99.5	14,447.4	19.00	578
Cauliflower	26	320.0		Mar. 16; Apr. 16	May 10; May 23	36 by 24	July 11–Aug. 9; Aug. 13–Aug. 30.	2,440	93.8	29.7	4,312.4	7.50	345
Cucumbers	26		15.0		May 11	72 by 48	Aug. 2–Sept. 6	3,656	140.6	93.7	17,006.6	5.62	680
Eggplant	22	83.6		Mar. 15	May 27	36 by 24	Aug. 25–Sept. 18	633	28.8	27.7	4,022.0	2.02	282
Muskmelons	25		14.6		May 12	72 by 48	Aug. 31–Sept. 18	1,030	41.2	28.1	5,100.2	2.06	255
Onions	25	1,760.0			Apr. 21	18 by 2	Sept. 17	15,790	631.6	35.6	10,338.2	25.26	414
Parsnips	25	320.0			do	36 by 3	Oct. 8	5,696	227.8	71.2	10,338.2	9.11	414
								Quarts	*Quarts*	*Quarts*	*Quarts*		
Peas	25	958.8			May 1; May 29	36 by 1	July 1–July 17; July 18–Aug. 6.	3,780	151.2	15.6	2,265.1	22.68	340
								Pounds	*Pounds*	*Pounds*	*Pounds*		
Peppers	20	80.0		Mar. 15	May 27	36 by 24	Aug. 24–Sept. 17	189	9.4	11.8	1,713.4	1.13	206
Potatoes	24	1,320.8			May 8	36 by 20	Aug. 2–Sept. 19	16,663	694.3	52.8	7,666.6	14.46	160
Pumpkins	25		28.0		May 11	108 by 96	Sept. 17–Oct. 3	14,573	582.9	208.2	12,596.1	11.66	252
Rutabagas	25	300.8			May 26	36 by 5	Sept. 30	6,841	273.6	90.1	13,082.5	10.94	523
Squashes, summer	25		10.2		May 11	72 by 48	July 26–Sept. 6	3,647	145.9	144.6	26,244.9	2.92	525
Squashes, winter	25		28.0		do	108 by 96	Sept. 16–Sept. 30	14,073	562.9	201.0	12,160.5	16.89	365
								Ears	*Ears*	*Ears*	*Ears*		
Sweet corn	25	2,534.4			May 8; May 28	36 by 26	Aug. 18–Aug. 24	25,872	1,034.9	41.0	5,953.2	21.56	124
								Pounds	*Pounds*	*Pounds*	*Pounds*		
Tomatoes	25	480.0		Mar. 16	May 27	36 by 30	July 29–Sept. 15	13,232	529.3	110.3	16,015.6	42.34	1,281
Watermelons	24	24.0			May 12	108 by 96	Sept. 7–Sept. 18	5,692	237.2	98.8	5,977.4	7.12	179

[1] More than 1 date for a single crop indicates early and later dates of planting or harvesting.

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Table 4 gives data on the variability of the different varieties grown, including their coefficients of variation, number of years that a variety yielded above and below average, and number of crop failures. The coefficients of variation for the various crops are graphically illustrated in figure 3. These coefficients are useful measures of the reliability of the different crops, high figures indicating marked variation in yields from year to year and low figures more reliable production. Crops with good average yields, low coefficients of variation, few failures, and yields not below average in too large a percentage of the years are apparently best adapted to the northern Great Plains (table 4 and fig. 3). Tomatoes, potatoes, pumpkins,

TABLE 4.—*Varieties, coefficients of variation, and yield data for crops grown in the acre garden, Northern Great Plains Field Station, Mandan, N. Dak., 1920–45*

Crop	Variety and season	Coefficient of variation	Yield data for 100-foot row or 10 hills						
			Average yield	Maximum yield		Years with yield below average		Years with yield above average	Years with crop failure
		Percent	*Pounds*	*Pounds*	*Year*	*Number*	*Percent*	*Number*	*Number*
Beans, shell	Pilot Navy	86	3.5	8.6	1924	14	56	11	7
			Quarts	*Quarts*					
Beans, snap	Burpee's Kidney Wax (late).	102	10.7	40.6	1927	14	56	11	7
Do	Burpee's Kidney Wax (early).	121	15.9	73.4	1928	18	72	7	5
Do	Pencil Pod Black Wax (early).	89	17.3	41.2	1944	6	67	3	1
Do	Pencil Pod Black Wax (late).	112	10.2	36.9	1945	6	67	3	3
Do	Burpee's Saddleback Wax (early).	105	19.9	69.1	1928	9	53	8	3
Do	Burpee's Saddleback Wax (late).	112	17.6	63.8	1927	10	62	6	5
			Pounds	*Pounds*					
Beets	Eclipse	58	60.1	139.7	1935	11	65	6	1
Do	Detroit Dark Red	62	103.3	247.5	1927	15	58	11	1
Cabbage	Early Jersey Wakefield	69	82.5	241.3	1922	12	46	14	2
Do	Copenhagen Market (early).	71	141.4	438.1	1922	16	64	9	2
Do	Copenhagen Market (late)	84	91.9	270.0	1924	17	65	9	4
Do	Danish Roundhead	88	85.9	229.4	1944	13	59	9	4
Carrots	Chantenay (medium)	60	121.4	269.4	1942	16	64	9	1
Do	Chantenay (early)	76	97.4	328.1	1927	11	48	12	1
Do	Chantenay (late)	90	80.0	235.0	1927	14	58	10	6
Cauliflower	Burpee's Best Early	80	40.3	131.9	1928	11	50	11	3
Do	Snowball (late)	114	17.4	70.6	1931	12	57	9	6
Cucumbers	Fordhook Famous	90	95.9	428.7	1923	15	60	10	3
Eggplant	Black Beauty	146	27.7	181.2	1923	16	73	6	7
Muskmelons	Emerald Gem	127	28.1	148.0	1923	17	68	8	4
Onions	Southport Yellow Globe	67	36.3	90.9	1927	15	60	10	2
Parsnips	Guernsey	67	71.2	151.6	1942	12	48	13	3
			Quarts	*Quarts*					
Peas	Nott's Excelsior (early)	58	14.9	27.8	1938	10	43	13	1
Do	Nott's Excelsior (late)	61	11.7	23.8	1924	9	43	12	1
Do	Alaska	64	18.0	38.1	1935	13	52	12	1
			Pounds	*Pounds*					
Peppers	Ruby King	89	11.8	40.0	1943	12	60	8	7
Potatoes	Early Ohio	38	52.3	89.9	1928	12	50	12	1
Pumpkins	Small Sugar	57	208.2	457.5	1924	10	40	15	2
Rutabagas	Golden Neckless	57	90.1	224.4	1927	13	52	12	1
Squashes, summer	Cocozelle	80	144.6	459.0	1945	15	60	10	3
Squashes, winter	Golden Hubbard	66	201.0	530.4	1920	13	52	12	4
			Ears	*Ears*					
Sweet corn	Burpee's Golden Bantam (late).	86	40.9	114.1	1942	15	62	9	5
Do	Burpee's Golden Bantam (early).	100	42.2	183.5	1928	17	68	8	4
			Pounds	*Pounds*					
Tomatoes	Sunnybrook Earliana	40	110.3	255.0	1927	14	56	11	1
Watermelons	Fordhook Early	120	98.8	395.0	1944	14	58	10	7

onions, rutabagas, early peas, beets, early and midseason plantings of carrots, squashes, parsnips, and early cabbage more nearly approach these requirements. On the other hand, eggplant, peppers, muskmelons, watermelons, cauliflower, and beans, which have high coefficients of variation, relatively lower yields, and more failures, seemingly have lower degrees of adaptation to the area. Considerable differences, however, sometimes exist between different varieties of the same crops or between early and late plantings of the same variety.

Seasonal precipitation and percentage yields of the different vegetable crops are shown in table 5. Since actual yields, which are in various units of measure, would place emphasis on high-yielding crops if yearly average for all crops were considered, percentage yields are given. Each figure for a given crop in any year represents the percentage of the average yield of that crop for the entire period. Thus, in 1941 peas yielded 95 percent of 15.6 quarts, the latter figure being the average yearly yield of 100 feet of row for the 25 years. As part of the data for 1929 are missing, this year is not included in table 5.

The 25 years are arranged in order from the year of highest seasonal precipitation to that of the lowest and divided into five groups of 5 years each. Average percentage yields are given for each group of 5 years. Of the 21 vegetable crops grown, 11 show highest average percentage yields for the first group, the 5 years of highest seasonal precipitation, 5 crops for the second, 4 for the third, 1 for the fourth, and none for the last, which includes the 5 years of lowest seasonal precipitation. The decrease shown from the first to the fifth group in the average yields for all crops grown indicates that seasonal precipitation is an important factor in crop production in the northern Great Plains.

Although a general decrease in percentage yields as the seasonal precipitation decreases is shown in table 5, many irregularities and exceptions are to be found. Injury from insects and diseases, damage from late-spring or early-fall frosts, poor stands, the distribution of the seasonal rainfall, and the quantity of moisture carried over in the soil from the previous season are other factors that influenced crop yields. Average percentage yields for certain years that seem to be out of line with the seasonal precipitation may be explained by some of these factors. For example, yields were higher than might be expected in 1945, but crops were doubtless benefited by heavy precipitation in the fall of 1944. Furthermore, the year having the highest seasonal precipitation, 1941, shows an average percentage yield of only 114. The heavy rains in September of that year (table 1) were too late to benefit most of the 1941 crops, but they resulted in increased yields for 1942. The yields of 1937 were much lower than might be expected from the seasonal precipitation, but there had been a drought in 1936. Likewise, yields for 1921 seem low, but 1920 was one of the dry years.

In spite of such irregularities, a statistical analysis of the table shows a definite relation between seasonal precipitation and crop yields. For the period covered, the coefficient of correlation between this precipitation and the crop yields is 0.75, with a t value of 5.27. The coefficient is not only high but also highly significant.

TABLE 5.—*Seasonal precipitation and relative average yields per 100 feet of row or 10 hills for vegetable crops grown in the acre garden, Northern Great Plains Field Station, Mandan, N. Dak., 1920–28 and 1930–45*

Year	Seasonal precipitation	Beans, shell	Beans, snap	Beets	Cabbage	Carrots	Cauliflower	Cucumbers	Eggplant	Muskmelons	Onions	Parsnips
	Inches	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
1941	16.86	44	11	124	44	104	99	172	82	425	78	152
1927	16.04	201	251	164	153	262	213	146	0	52	255	182
1928	15.93	228	299	96	224	101	268	167	108	36	133	37
1943	15.41	154	92	113	112	152	14	140	314	0	112	149
1944	14.92	176	219	81	122	59	87	90	108	36	99	156
Average	15.83	161	174	115	131	136	142	143	122	110	135	135
1935	14.84	55	25	126	129	99	118	87	86	256	181	47
1942	14.62	132	10	131	140	217	108	179	(1)	204	65	113
1924	13.41	236	201	169	221	60	205	103	60	78	191	188
1937	12.86	33	20	68	29	29	88	25	90	0	[2] 3	(3)
1931	12.66	0	171	106	149	178	195	60	0	62	187	167
Average	13.68	91	85	120	134	117	143	91	59	120	125	123
1923	12.55	201	175	106	36	128	4	442	625	527	213	197
1930	12.40	0	3	120	100	104	33	104	39	28	84	108
1925	12.09	(4)	131	115	129	146	100	63	43	28	99	99
1922	11.94	228	245	144	277	184	224	104	(5)	116	121	147
1921	11.67	35	20	69	113	65	58	52	(5)	107	57	42
Average	12.13	116	115	111	131	125	84	153	236	161	115	119
1940	11.65	107	85	140	40	94	24	70	0	64	109	112
1932	11.64	44	48	111	97	60	112	64	52	43	82	86
1945	11.61	192	229	198	99	179	101	173	138	133	145	140
1938	11.37	88	79	88	76	34	134	94	263	95	97	125
1939	11.37	0	5	57	52	83	146	84	56	31	47	82
Average	11.53	86	89	119	73	90	103	97	102	73	96	109
1920	9.93	184	122	64	78	45	56	40	(5)	110	96	29
1926	9.62	60	57	50	70	72	83	40	39	53	22	34
1933	7.35	0	0	42	11	37	0	0	0	14	26	8
1934	6.40	0	0	18	0	7	0	0	0	0	0	0
1936	2.96	0	0	0	0	0	0	0	0	0	0	0
Average	7.25	49	36	35	32	32	28	16	10	35	29	14
25-year average	12.08											
Average yield		*Pounds* 3.6	*Quarts* 16.7	*Pounds* 89.5	*Pounds* 103.8	*Pounds* 101.1	*Pounds* 30.2	*Pounds* 96.9	*Pounds* 29.0	*Pounds* 28.1	*Pounds* 35.6	*Pounds* 71.2

See footnotes at end of table.

TABLE 5.—*Seasonal precipitation and relative average yields per 100 feet of row or 10 hills for vegetable crops grown in the acre garden, Northern Great Plains Field Station, Mandan, N. Dak., 1920–28 and 1930–45*—Continued

Year	Peas	Peppers	Potatoes	Pumpkins	Rutabagas	Squashes, summer	Squashes, winter	Sweet corn	Tomatoes	Watermelons	Average (all vegetables)
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
1941	95	106	78	51	60	157	41	25	59	386	114
1927	118	159	149	147	249	204	120	113	231	67	164
1928	150	106	170	191	82	76	197	356	110	0	149
1943	122	339	99	131	105	86	140	80	9	0	119
1944	190	95	111	120	178	156	162	220	210	395	146
Average	135	161	121	128	135	136	132	158	124	170	138
1935	174	74	120	30	160	156	75	148	118	100	113
1942	167	233	97	130	152	285	133	248	91	83	151
1924	157	297	140	220	158	64	160	256	127	104	162
1937	29	[4]	78	58	43	124	95	88	90	127	56
1931	85	42	104	105	158	55	62	8	87	157	102
Average	122	162	108	109	134	137	105	150	103	114	117
1923	88	[5]	150	103	173	28	102	158	148	75	184
1930	47	52	86	52	130	80	50	46	94	[6] 12	65
1925	92	0	96	115	68	140	104	165	142	[3]	94
1922	107	[5]	148	112	104	97	100	133	180	250	159
1921	32	[5]	[4]	112	52	10	0	48	67	[7]	55
Average	73	26	120	99	105	71	71	110	126	84	111
1940	131	0	61	70	39	51	78	70	82	169	76
1932	116	52	104	112	73	81	90	79	114	14	78
1945	184	318	114	191	107	317	208	116	199	10	166
1938	153	127	111	165	71	61	139	76	84	196	112
1939	142	0	62	55	40	120	69	0	107	0	59
Average	145	99	90	119	66	126	117	68	117	78	98
1920	29	[5]	146	115	94	45	264	23	86	153	94
1926	38	0	64	99	111	103	114	41	34	[7]	59
1933	24	0	58	15	21	0	0	0	5	0	12
1934	29	0	55	0	73	0	0	0	22	0	10
1936	0	0	0	0	0	0	0	0	0	0	0
Average	24	0	65	46	60	30	76	13	29	38	35
	Quarts	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Ears*	*Pounds*	*Pounds*	
Average yield	15.6	11.8	52.8	208.2	90.1	144.6	201.0	41.0	110.3	100.0	

[1] Damped-off in greenhouse.
[2] Poor germination.
[3] No stand.
[4] Data lost.
[5] None planted.
[6] Hail damage.
[7] Stolen or destroyed.

TABLE 6.—*Yields per 100 feet of row or per 10 hills for varieties of vegetables grown in the acre garden, Northern Great Plains Field Station, Mandan, N. Dak., 1920–45*

Year	Beans, shell		Beans, snap											Beets						
	Great Northern	Pilot Navy	Bountiful		Burpee's Kidney Wax		Pencil Pod Black Wax		Burpee's Saddleback Wax		Tendergreen		Unknown variety	Burpee's White Wax	Detroit Dark Red	Early Blood Turnip	Early Flat Egyptian	Early Wonder	Eclipse	Ohio Canner	Burpee's Red Ball
			Early	Late	Early	Late	Early	Late	Early	Late	Early	Late									
	Pounds	*Pounds*	*Quarts*	*Quarts*	*Quarts*	*Quarts*	*Quarts*	*Quarts*	*Quarts*	*Quarts*	*Quarts*	*Quarts*	*Quarts*	*Quarts*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
1920	6.8	6.6			13.4				24.1				22.2	21.9	68.1				46.9		
1921		1.3			3.8	4.1			1.6	3.8					74.4				48.8		
1922		8.3			59.1	13.1			52.5	38.8					174.4				83.8		
1923		7.3			24.1	23.8			37.2	32.2					131.2				59.4		
1924		8.6			32.2	29.1			30.9	41.9					191.6				110.9		
1925		(2)			29.4	17.8			25.3	15.0					171.2				34.4		
1926		2.2			8.4	15.0			7.5	7.5					43.1				45.6		
1927		7.3			15.6	40.6			48.1	63.8					247.5		45.3				
1928		8.3			73.4	20.6			69.1	36.9					131.2				40.0		
1929		.0			.0	.0			6.9	3.1					47.5				40.9		
1930		.0			.0	.0			1.9	.0					181.2				34.4		
1931		.0			33.4	22.8			25.9	32.2					95.0				94.7		
1932		1.6			9.4	10.9			4.7	6.9					100.0				98.4		
1933		.0			.0	.0			.0	.0					15.6				59.4		
1934		.0			.0	.0			.0	.0					18.8				14.1		
1935		2.0			6.9	6.9			2.5	.0					85.6				139.7		
1936		.0			.0	.0			.0	.0					.0				.0		
1937		1.2			1.9	2.5	4.4	5.0							52.5				69.7		
1938		3.2			14.1	9.4	13.8	15.3							74.4		83.8				
1939		.0			.9	2.5	.0	.0							56.2		46.2				
1940		3.9			10.0	25.3	13.8	7.8							158.1	93.4					
1941		1.6			3.1	.0	4.4	.0							[7] 12.5	209.4					
1942		4.8			1.6	.0	4.7	.0							171.9		62.2				
1943		5.6			15.9	2.5	35.3	8.1							128.1		74.1				
1944		6.4	68.1	26.9	50.0	12.5	41.2	18.8			51.9	23.8			86.2			83.1			47.5
1945		7.0	77.5	56.3	7.5	7.5	38.1	36.9			45.0	37.5			168.4					186.2	
Average		3.5			15.9	10.7	17.3	10.2	19.9	17.6					103.3		62.3		60.1		

See footnotes at end of table, p.17.

TABLE 6.—*Yields per 100 feet of row or per 10 hills for varieties of vegetables grown in the acre garden, Northern Great Plains Field Station, Mandan, N. Dak., 1920–45*—Continued

Year	Cabbage						Carrots					Cauliflower			
	Copenhagen Market		Danish Round-head	Early Jersey Wake-field	Glory of Enk-huizen	Surehead	Chantenay			Danvers Half Long	Nantes (Core-less)	Burpee's Best Early	Bur-peeana	Danamerica	
	Early	Late					Early	Medium	Late					Early	Late
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*
1920		60.9		101.0				45.3				28.8			
1921	169.7	89.1		55.6	153.1		94.4	103.8	0.0			17.5			
1922	438.1	191.9		241.3		280.0	228.8	214.4	116.2			84.4			
1923	87.5	(4)		23.8			118.8	190.0	80.0			2.5			
1924	331.3	270.0	201.3	115.0			37.5	76.2	67.5			66.3			
1925	182.5	148.1	58.1	145.0			116.2	173.1	153.8			53.1			
1926	98.8	78.1	43.8	70.0			100.0	118.8	(4)			42.5			
1927	195.0	206.3	146.9	86.3			328.1	232.5	235.0			78.8			
1928	299.4	256.6	190.6	181.3			105.6	100.0	100.0			131.9			
1929	80.0	49.7	39.4	37.5			24.4	101.2	54.4			30.0			
1930	104.4	59.1	145.0	108.1			98.1	112.5	105.2			13.1			
1931	204.4	171.3	106.3	137.5			141.9	197.5	199.4			46.9			
1932	213.8	73.1	25.0	93.1			60.6	60.6	69.6			65.0			
1933	5.6	17.8	12.5	8.8			50.0	61.2	(4)			.0			
1934	.0	.0	.0	.0			7.5	7.5	6.9			.0			
1935	180.0	161.3	78.8	116.9			116.9	105.6	78.8			48.8			
1936	.0	.0	.0	.0			.0	.0	.0			.0			
1937	75.6	.0	28.1	15.0			30.6	36.2	22.5			45.0			
1938	141.3	59.1	.0	114.4			25.6	77.5	(4)			61.9			
1939	75.0	41.3	23.8	76.9			41.2	109.4	100.6				56.3		31.9
1940	104.4	37.2	.0	23.1			85.6	200.6	(4)						
1941	62.5	17.2	68.8	33.1			156.2	131.2	27.5					35.0	25.0
1942	131.3	134.4	208.1	107.5			165.6	269.4	222.5			34.4			
1943	105.0	103.1	150.6	108.1			106.9	238.1	116.9			14.4			
1944	111.9	80.0	229.4	86.9				71.9	61.9		45.0	20.6			
1945	136.9	83.1	133.8	57.5					188.1	181.2	173.8				
Average	141.4	91.9	85.9	82.5			97.4	121.4	80.0			40.3			

See footnotes at end of table, p. 17.

TABLE 6.—*Yields per 100 feet of row or per 10 hills for varieties of vegetables grown in the acre garden, Northern Great Plains Field Station, Mandan, N. Dak., 1920–45*—Continued

Year	Cauliflower—Con.			Cucumbers		Eggplant (Black Beauty)	Muskmelons (Emerald Gem)	Onions		Parsnips (Guernsey)	Peas									
	Dry Weather	Snowball		Davis Perfect	Fordhook Famous			Australian Brown	Southport Yellow Globe		Alaska	Alderman	Carter's Daisy		Lincoln		Little Marvel		Nott's Excelsior	
		Early	Late										Early	Late	Early	Late	Early	Late	Early	Late
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Quarts*	*Quarts*	*Quarts*	*Quarts*	*Quarts*	*Quarts*	*Quarts*	*Quarts*	*Quarts*	*Quarts*
1920			5.0	38.7			31.0	34.5	34.0	20.9	4.4								4.6	
1921			(1)		50.0		30.0		20.2	30.3	7.5								3.4	4.4
1922			50.6		100.7		32.7	25.8	60.4	104.7	14.1								22.2	13.8
1923			(4)		428.7	181.2	148.0		75.7	140.6	12.2								16.3	12.5
1924	57.5				100.0	17.5	22.0		67.9	134.1	27.5								22.2	23.8
1925	7.5				61.3	12.5	8.0		35.1	70.3	23.4								12.8	6.9
1926	7.5				38.7	11.2	15.0		8.0	24.1	7.8								5.3	5.0
1927			50.0		141.3	.0	14.7		90.9	129.4	17.2								18.8	19.1
1928			30.0		162.0	31.2	10.0		47.4	26.6	33.8								23.8	12.5
1929			3.1		15.3	.0	(2)		(2)	(2)	(2)								(2)	(2)
1930			6.9		101.3	11.2	8.0		29.9	76.6	5.6								12.2	4.4
1931			70.6		58.0	.0	17.3		66.6	119.1	14.1		11.9	12.8					14.4	
1932			3.1		62.0	15.0	12.0		29.3	60.9	30.3								16.9	7.2
1933			.0		.0	.0	4.0		9.1	5.6	3.8								5.0	2.2
1934			.0		.0	.0	.0		.0	.0	6.3								3.8	3.8
1935			22.5		84.0	25.0	72.0		64.4	33.4	38.1								27.2	15.9
1936			.0		.0	.0	.0		.0	.0	.0								.0	.0
1937			8.1		24.7	26.2	.0		7 1.1	(4)	4.1								4.1	5.3
1938			19.4		90.7	76.2	26.7		34.5	89.1	21.3								27.8	22.2
1939					81.3	16.2	8.7		16.8	58.1	37.2								16.6	12.8
1940		14.4	.0		68.0	.0	18.0		38.9	79.7	18.1								23.8	19.4
1941					166.7	23.8	119.3		27.6	108.4	9.1								21.9	13.4
1942			30.6		173.3	(3)	57.3		23.1	151.6	29.7								25.6	23.1
1943			11.9		135.3	91.2	.0		40.0	106.2	24.4								15.0	17.8
1944			31.9		87.3	31.2	10.0		35.2	110.9	35.0						33.4	20.6		
1945	38.8		21.9		168.0	40.0	37.3		51.5	99.4	23.8	32.3			40.0	30.0	26.9	19.4		
Average			17.4		95.9	27.7	28.1		36.3	71.2	18.0								14.9	11.7

See footnotes at end of table, p. 17.

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TABLE 6.—*Yields per 100 feet of row or per 10 hills for varieties of vegetables grown in the acre garden, Northern Great Plains Field Station, Mandan, N. Dak., 1920–45*—Continued

Year	Peppers (Ruby King)	Potatoes			Pumpkins (Small Sugar)	Rutabagas (Golden Neckless)	Squashes, summer (Cocozelle)	Squashes, winter (Golden Hubbard)	Sweetcorn (Burpee's Golden Bantam)		Tomatoes (Sunnybrook Early-iana)	Watermelons (Fordhook Early)
		Early Ohio	First of All	Triumph					Early	Late		
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Pounds*	*Ears*	*Ears*	*Pounds*	*Pounds*
1920		64.5	108.3	59.4	240.0	84.4	65.3	530.4	9.5		95.4	153.3
1921		[2]			232.9	46.9	15.0	.0	2.3	36.7	73.8	[3]
1922		78.1			232.5	93.8	140.0	200.0	54.7	54.7	198.8	250.0
1923		79.0			214.3	156.2	41.0	204.3	71.9	57.9	163.5	75.0
1924	35.0	74.2			457.5	142.8	93.0	321.4	96.1	113.4	140.0	104.2
1925	.0	50.7			239.3	61.6	203.0	210.0	99.9	35.4	156.4	[4]
1926	[5]	33.8			207.1	100.0	149.0	228.6	23.4	10.0	37.5	[3]
1927	18.8	78.9			305.4	224.4	295.0	240.7	29.3	63.0	255.0	66.7
1928	12.5	89.9			396.8	74.1	110.0	395.7	183.5	108.1	121.9	.0
1929	[2]	[2]			[2]	[2]	[2]	[2]	[2]	[2]	[2]	72.9
1930	6.2	45.6			108.9	116.9	116.0	101.4	20.9	6.6	104.2	[6]11.7
1931	5.0	54.8			219.2	142.2	80.0	124.6	6.6	.0	96.4	156.7
1932	6.2	54.8			233.2	65.6	118.0	181.4	27.0	38.0	126.2	13.8
1933	.0	30.5			31.4	18.8	.0	.0	.0	.0	5.2	.0
1934	.0	29.2			.0	65.6	.0	.0	.0	.0	24.0	.0
1935	8.8	63.3			62.1	143.8	225.0	150.0	62.3	59.5	130.0	100.0
1936	.0	.0			.0	.0	.0	.0	.0	.0	.0	.0
1937	[2]	41.0			121.1	39.1	179.0	191.1	40.5	31.9	99.6	127.1
1938	15.0	58.4			343.6	64.1	88.0	278.6	23.4	39.5	93.1	196.3
1939	.0	32.7			114.6	35.9	174.0	138.6	.0	.0	118.3	.0
1940	.0	32.2			146.4	35.3	74.0	157.1	22.5	35.0	91.0	169.2
1941	12.5	41.3			107.1	53.8	227.0	82.1	9.1	11.3	65.6	386.3
1942	27.5	51.2			270.4	137.2	412.0	267.5	89.0	114.1	100.0	83.3
1943	40.0	52.1			272.5	94.4	125.0	280.4	36.7	29.3	9.6	.0
1944	11.2	58.4			250.0	160.6	226.0	325.0	104.7	75.3	231.9	395.0
1945	37.5	60.1			398.2	96.2	459.0	417.1	22.8	62.9	219.2	10.4
Average	11.8	52.3			208.2	90.1	144.6	201.0	42.2	40.9	110.3	98.8

[1] Cutworms or rabbits destroyed crop.
[2] Data lost.
[3] Stolen or destroyed.
[4] No stand.
[5] Few.
[6] Hail damage.
[7] Poor germination.
[8] Damped-off in greenhouse.

Yearly and average yields calculated for 100 feet of row or for 10 hills in the case of vine crops for the different varieties of vegetables grown in the acre garden from 1920 to 1945, inclusive, are given in table 6. Averages for varieties grown for less than 5 years are of comparatively little value and are omitted.

VEGETABLE CROPS GROWN AT MANDAN

Asparagus

Asparagus is probably the most important of the perennial vegetable crops adapted for planting in northern Great Plains gardens. It furnishes a fresh vegetable for use in early spring, when most vegetable seeds are just being planted.

Perennial vegetables, such as asparagus, rhubarb, horseradish, and perennial onions, should be planted at one side of the garden or in some other place where they will not interfere with plowing or any rotation system that may be planned for the annual crops. Since the asparagus planting will last for many years, a heavy application of well-rotted manure should be plowed into the soil in the fall before planting. Further applications of manure may be made at intervals during the life of the planting, usually just after the cutting season.

Planting should be done in April, a plow being used to open a furrow for the plants. The rows should be 4 to 6 feet apart and the plants spaced 1½ to 2 feet in the row. The roots of the plants should be well spread out at a depth of about 6 inches below the surface and then covered with 3 to 4 inches of well-packed soil. Cultivation during the season works the rest of the soil into the rows. Vigorous 1-year-old plants are preferable. Such plants may be grown on the farm from seed, but they are generally purchased from some nursery for the home garden.

Care should be taken that the plants are not weakened by too heavy cutting, particularly during the first few years. Little cutting should be done the first 3 years and should cease before the first of June in later years. The average date of the first cutting at Mandan was May 6, and of the last June 9. The asparagus was cut when 6 to 8 inches high, the cut being made a little below the surface of the ground. Cutting was done every other day as a general rule, but it should be done more often in warm than in cool weather. Insects and diseases caused but little trouble.

One planting of three varieties, two rows of each planted 4 feet apart, was started in 1920. There was some crowding of the variety in the middle two rows, especially in later years, resulting in much lower yields than for the two varieties having outside rows. This planting was still producing good asparagus in 1948, but yields were tending to diminish as crowding increased. The average annual yield for the period 1923–46 was 19 pounds to 100 feet of row. No failures were recorded, fair yields being obtained even in the drought years 1934 and 1936 when many annual crops failed. The coefficient of variation for this crop for the period 1923–46 was 28 percent, which is considerably lower than that for any of the annual vegetable crops (fig. 3) and indicates very reliable production from year to year.

Beans

The beans grown in northern Great Plains gardens are shell, or dry, beans, snap, or string, beans, pole beans, soybeans, lima beans, and broadbeans. Of these, the bush type of snap beans is most commonly grown.

Planting should be delayed until the ground warms up and danger of damage from late-spring frosts is past. Most beans should be planted about the middle of May, but the early planting of snap beans may be made a week sooner. In order to lengthen the season for use, successional plantings of an early variety of bush snap bean may be made at 10-day intervals from the first part of May until the first part of June or varieties that ripen at different dates may be planted about May 10. Most beans are planted in rows about 20 inches or 3 feet apart, the latter distance being for horse cultivation. Shell beans are thinned to about 3 inches apart in the row and bush snap beans to 4 or 5 inches. Pole beans require some support, rough poles 7 to 9 feet high often being used and spaced 2½ to 3 feet apart in the row. Often the tops of two or three poles are tied together. The beans are planted around the poles and later thinned to three or four plants for each. For horse cultivation, the rows for pole beans should be about 4 feet apart.

In order to obtain maximum yields and a good-quality product, snap beans should be harvested frequently and before they are too mature. The pole beans come on after most of the bush beans are gone and produce until early fall. Shell beans are harvested about the middle of September when they reach full maturity and the pods become brown and dry. Early-maturing varieties of shell and lima beans and soybeans should be chosen, since damage from early-fall frosts often occurs.

Insects were not troublesome, except that blister beetles damaged broadbeans. Since diseases, especially bacterial blight, caused heavy damage in some years, disease-free seed is important.

Shell beans (Pilot Navy), having an average yield of only 3.5 pounds to 100 feet of row, are the lowest in average yield and in value on an acre basis of all vegetable crops tested (table 3). They failed to produce in 7 out of the 25 years under test because of drought, failure to mature before fall frosts, or disease. Yields below the average were recorded in 14 of the 25 years and above average in 11. The coefficient of variation (86 percent) is a little above the average for all vegetable crops and indicates that shell beans rank near the middle in tendency to vary in yields from year to year (table 4). Great Northern or Hidatsa Red probably would have given higher yields than Pilot Navy.

Snap beans gave fair yields, the average yield for all plantings for the 26-year period 1920–45 being 16.2 quarts to 100 feet of row (table 3). Yields and the value of the crop on an acre basis were rather low as compared with those of most of the other vegetables tested. The crop produced below-average yields far more often than above-average yields, and the high coefficient of variation (110 percent) indicates considerable variation in yields from year to year (fig. 3). It is probable, however, that snap beans would have given a better account of them-

selves if higher yielding varieties such as Bountiful and Pencil Pod Black Wax instead of Burpee's Saddleback Wax and Burpee's Kidney Wax had been used throughout the 26-year period.

Burpee's Saddleback Wax and Burpee's Kidney Wax were grown in the acre garden more often than other varieties. Early and late plantings of these varieties may be compared for the 16-year period 1921–36. The average yields to 100 feet of row were as follows: Saddleback Wax, early planting, 19.6 quarts; Saddleback Wax, late planting, 17.6 quarts; Kidney Wax, early planting, 18.5 quarts; and Kidney Wax, late planting, 12.8 quarts.

The early plantings were made on the average date May 9 and the late plantings on the average date May 28. Yields from the early plantings of Saddleback Wax were greater than those from the late plantings in 7 years of the 16-year period and less in 5. They both failed or their yields were equal in 4 years. Only three failures were recorded for the early planting as compared with five for the late. The early plantings of Kidney Wax beans had higher yields than the late plantings in 6 of the 16 years, the late plantings were better in 4, and both were equal or failures in 6; the number of failures were the same for both.

Early plantings of Saddleback Wax and Kidney Wax beans may be compared for the 17-year period 1920–36: average yields were 19.9 quarts to 100 feet of row for the former and 18.2 quarts for the latter. Saddleback Wax yielded more than Kidney Wax in 5 of the 17 years, Kidney Wax had greater yields in 9, and both failed in 3. Saddleback Wax failed in only 3 years and the Kidney Wax in 5. Late plantings of Saddleback Wax and Kidney Wax beans may be compared for the 16-year period 1921–36; average yields were 17.6 quarts to 100 feet of row for the former and 12.8 quarts for the latter. Saddleback Wax had greater yields in 7 of the 16 years and Kidney Wax in 5, and both failed in 4.

Early and late plantings of Kidney Wax beans may be compared for the 25-year period 1921–45; average yields were 16.0 quarts to 100 feet of row for the early planting and 10.7 quarts for the late. The early planting yielded more in 11 of the 25 years and the late planting in 7, and they were equal or failures in 7. Failures were recorded in 5 years for the early planting and in 7 for the late.

Early and late plantings of Pencil Pod Black Wax and Kidney Wax beans may be compared for the 9-year period 1937–45. The average yields to 100 feet of row were as follows: Pencil Pod Black Wax, early planting, 17.3 quarts, and late planting, 10.2 quarts; Kidney Wax, early planting, 11.7 quarts, and late planting, 6.9 quarts.

Yields from the early plantings of Pencil Pod Black Wax were higher than those from the late plantings in 6 of the 9 years and yields from the late plantings higher in 2, and they both failed in 1939. The early plantings had one failure as compared with three for the late plantings. The early plantings of Kidney Wax beans yielded better in 5 of the 9 years and the late plantings in 3, and they were equal in 1. No failures were recorded for the early plantings, but the late plantings faile l twice.

Early and late plantings of Kidney Wax, Pencil Pod Black Wax, Bountiful, and Tendergreen may be compared for 1944 and 1945. The average yields to 100 feet of row were as follows:

Variety:	*Early planting (quarts)*	*Late planting (quarts)*
Kidney Wax	28. 7	10. 0
Pencil Pod Black Wax	39. 7	27. 8
Bountiful	72. 8	41. 6
Tendergreen	48. 4	30. 6

Average yields for early plantings exceeded those for late plantings of all four varieties. Although the period was not long enough to be conclusive, this and other tests indicate that green-podded varieties such as Bountiful and Tendergreen will yield at least as well as the wax-podded.

Although the data just presented favor early plantings of snap beans on the average date May 9 as compared with late plantings on the average date May 28, the differences in no cases are significant as shown by Student's method of pairing. The short period, the lack of replication, and the instability of the varieties grown may account for this seeming conflict. All P values are greater than 0.1.[6] But even though the differences between early and late plantings cannot be proved to be significant in any given case, the fact that all the data favor the early plantings is a strong indication that the grower may expect higher yields from early plantings in most years. Late plantings, however, are desirable for lengthening the time of production.

Beets

Beets are a good crop for the northern Great Plains gardens, being used for greens, pickles, a freshly cooked table vegetable, canning, and winter storage.

Beets for greens and summer use should be planted about the first of May and those for winter storage during the latter part so that they will not become too large and coarse. Rows may be about 18 inches apart or, for horse or tractor cultivation, 3 feet apart. The plants are gradually thinned to 3 or 4 inches apart in the row, the thinnings being used for greens, pickles, and small beets for the table. Beets are ready to be harvested for storage about the middle of September. They keep well when stored in sand in a cool root cellar. Webworms, flea beetles, and blister beetles caused some damage to beets at Mandan, but diseases were not troublesome.

The average yield of 87.8 pounds to 100 feet of row, or 12,748.6 pounds on an acre basis, for all beets grown during the 26-year period places them well above the general average of all vegetable crops, both as to yield and value on an acre basis (table 3). Yields ran below the average more often than above, but the only failure recorded was in the drought year 1936. The coefficient of variation (60 percent) is lower than for most other vegetable crops and indicates reliable production from year to year (fig. 3).

The varieties Eclipse and Detroit Dark Red may be compared for the period 1920–37 exclusive of 1927 when Eclipse was not grown, or for 17 years. The average yield for this period for Detroit Dark Red was 93.0 pounds to 100 feet of row as compared with 60.1 pounds for Eclipse. The former variety yielded more in 12 of the 17 years and Eclipse more in 4, and both failed in 1936.

[6] The years in which both plantings of a comparison failed are omitted from this calculation and others that may follow.

Early Flat Egyptian may be compared with Detroit Dark Red in 1927, 1938, 1939, 1942, and 1943. Average yields for these years were 135.6 pounds to 100 feet of row for Detroit Dark Red and 62.3 for Early Flat Egyptian. The Detroit Dark Red yielded more than the Early Flat Egyptian in all but 1 of the 5 years. According to Student's method of pairing, however, Detroit Dark Red was not significantly better than Eclipse or Early Flat Egyptian, P being greater than 0.08 in both instances.

Broccoli

Although broccoli is not so widely grown as its relatives, cabbage and cauliflower, it is becoming more important in northern Great Plains gardens. The Italian Green Sprouting types, which produce small heads at the end of the main stem and from axils of leaves, are grown. This vegetable makes a palatable dish when cooked in the same manner as cauliflower if the heads are cut before they are too mature.

The culture of broccoli is similar to that of cabbage and cauliflower, the plants being started indoors and later transplanted to the garden. Cabbage caterpillars and aphids (plant lice) were the most troublesome insect pests.

The harvest season at Mandan extends from about the middle of July until late September. The average yield for the 4 years when yields were taken was 19.3 pounds to 100 feet of row. No failures were recorded, but broccoli was not planted in the drought years 1934 and 1936.

Brussels Sprouts

Brussels sprouts may be grown according to the directions given for cabbage and cauliflower. Since varieties tested at Mandan over a period of 7 years did not mature usable sprouts or heads early enough to escape fall freezes, this vegetable cannot be recommended for the northern Great Plains.

Cabbage

Cabbage is well adapted for planting in the northern Great Plains and is one of the more important crops grown in home gardens. It is used raw, cooked, and as kraut.

Cabbage plants are generally produced in greenhouses, warm windows, hotbeds, or coldframes. Seed is planted from the latter part of March to the middle of April, depending on whether the cabbage is for early or late use and on the facilities available for growing the plants. The plants should be transplanted from the original seed flats and spaced about 2 inches apart in others. They are ready for planting in the garden about 6 to 8 weeks after the seed is sown, before the middle of May for early cabbage and in late May for late cabbage. The plants are set in rows about 3 feet apart and spaced about 2 feet in the row, early varieties being spaced a little closer than late.

Early cabbage is ready to use in July and is harvested as soon as the heads are sufficiently large and firm. Late cabbage is harvested in late September or early October, before severe fall frosts. Storage is best on shelves in a cool place that is neither too dry nor too humid.

Cabbage caterpillars, flea beetles, and aphids were the most common insect pests, but diseases were not troublesome.

Cabbage ranked relatively high both in yield and in the value of the product on an acre basis (table 3). The coefficient of variation (80 percent) indicates that although cabbage was not so reliable in yield as some other crops, the variation from year to year was not excessive (fig. 3). Complete failures were recorded only for the drought years 1934 and 1936.

For early cabbage, the varieties Early Jersey Wakefield and the early planting of Copenhagen Market may be compared for the 25-year period 1921–45; the average yields were 141.4 pounds to 100 feet of row for the Copenhagen Market and 81.7 for the Early Jersey Wakefield. This superiority of Copenhagen Market is significant. Copenhagen Market outyielded Early Jersey Wakefield in 19 of the 25 years and fell below it in only 4. Both varieties failed in 2 years.

The late plantings of Copenhagen Market may be compared with those of Danish Roundhead for the 22-year period 1924–45; the yield of Copenhagen Market averaged 93.0 pounds to 100 feet of row and that of Danish Roundhead 85.9 pounds. The Copenhagen Market yielded best in 13 years and the Danish Roundhead in 7, and both failed in 2. During the period Copenhagen Market failed three times and Danish Roundhead four. Student's method of pairing shows the difference to be significant for the first 15 years when yields were obtained for both, but not for the entire period. During the last 5 years the yield of Danish Roundhead was significantly more than that of Copenhagen Market, averaging 74.5 pounds more; whereas during the first 15 years when yields were obtained for both, the latter yielded an average of 35.3 pounds more than Danish Roundhead.

Early and late plantings of Copenhagen Market may be compared for the 25-year period 1921–45. Average dates were March 16 in the greenhouse and May 10 in the garden for the early and April 13 in the greenhouse and May 22 in the garden for the late plantings. The early plantings averaged 141.4 pounds to 100 feet of row as compared with only 93.1 pounds for the late and were significantly better. They had higher yields in 20 of the 25 years and lower in 3. Both plantings failed in 2 years. One reason for the better results of the early plantings is that the heads were less prone to split or burst open.

Carrots

Carrots, a favorite in home gardens, are well adapted to the area. For early use, carrots may be sown as early in the spring as the land is ready. Successional plantings at 10-day intervals furnish a good-quality product over a long period. Plantings for fall use or winter storage should be made in the latter part of May, since earlier plantings may result in excessively large, coarse roots of poor quality. Rows are spaced about 15 inches, or 3 feet apart for horse cultivation, and the carrots are thinned to about 2 inches apart in the row. The main crop is harvested in October before severe fall freezes and may be stored in dry sand in a cool root cellar. Insects and diseases were not troublesome.

Carrots, as represented by the variety Chantenay, had for the period grown an average yield of 99.5 pounds to 100 feet of row, or 14,447.4 pounds on an acre basis. They were one of the highest yielding crops in the acre garden and ranked relatively high in acre value (table 3). The relatively low coefficients of variation (table 4) indicate that the variation in yields from year to year was not excessive.

The average early date of planting for this crop was April 22, the medium May 10, and the late May 29. Average yields to 100 feet of row for the 23-year period 1921–43 were 97.4 pounds for the early planting date, 126.8 pounds for the medium, and 76.0 pounds for the late. The medium date of planting resulted in highest yields in 14 of the 23 years, the early in 5, and the late in 1. Yields from crops planted on the early and medium dates were equal in 1 year, and all yields failed or were equal in 2. Only one failure each was recorded for the early and medium plantings, but the late planting failed six times. The medium planting yielded significantly more than the early or late, but the early planting did not yield significantly more than the late.

Cauliflower

Cauliflower is not so commonly grown as its relative cabbage and is more particular in climatic and other requirements. It seldom does well in dry years.

Plants are started inside and handled much the same as cabbage plants. They are planted in the garden at about the same time as cabbage and spaced at the same distances. When the head is partly grown, the outer leaves are tied over it to protect it from the sun in order to produce the attractive white head desired. The heads should be harvested when large enough to use, since they deteriorate if left too long, and should be used within a reasonable time, since they do not store well. Insects and diseases were much the same as those for cabbage.

Cauliflower had for the period an average yield to 100 feet of row of only 29.7 pounds, or less than one-third that of cabbage (table 3). It is not so consistent a producer as cabbage as shown by the high coefficient of variation (fig. 3) : failures were relatively frequent and yields were below the average more often than above (table 4).

The varieties Burpee's Best Early and Snowball may be compared for 19 years of the 26-year period; the former had an average yield of 38.1 pounds to 100 feet of row and the latter only 18.1 pounds. Burpee's Best Early yielded significantly better for these years. It yielded better in 14 of the 19 years and failed in 3, and Snowball yielded better in 2 and failed in 5. This is not a fair comparison between the two varieties, however, since the earlier planting of Burpee's Best Early may account for much of the difference in yield.

Celeriac, or Turnip-Rooted Celery

Celeriac, or turnip-rooted celery, is seldom grown in gardens of the area but is esteemed by some people for its edible roots, which are boiled or used in soups and stews. Culture is similar to that of celery except that blanching is not required. Giant Prague was the usual variety grown at Mandan; but since it often failed to mature usable roots before fall freezes, celeriac would appear to be a very uncertain crop in the northern Great Plains.

Celery

Although not very common in northern Great Plains gardens, celery is frequently used either raw or cooked or for flavoring soups or

other dishes. Since this vegetable does best on a rich soil, the land should be well manured. Although it can be grown under dry-land conditions in most years, irrigation is very desirable to increase its size and improve its quality.

Celery is started indoors from the middle to the end of March, transplanted to flats when the first true leaves appear, and set out in the garden in late May or early June. Rows should be 3 to 4 feet apart and the plants spaced about 6 inches in the row. Blanching is done by placing 12-inch boards on either side of the row or by banking soil around the stems, usually after a good irrigation in early August. The unblanched product, however, is preferred by some. Harvesting may begin in early September. Plants for storage should be dug before severe freezes, with considerable soil left around the roots, and stored in moist soil or sand in a cool root cellar.

As grown at Mandan, this crop rated only fair in reliability of production. Rot (probably late blight) caused damage in some years. Golden Plume was the best variety tested.

Chinese Cabbage

Chinese cabbage, although little grown, is becoming more popular in certain sections. It is used as a salad or cooked like ordinary cabbage. Since it tends to go to seed in hot weather without forming heads if sown in early spring, it should not be planted until late June or early July. The plants are thinned to stand about 1 foot apart in the row. The crop is somewhat uncertain, since many plants do not form firm heads in time to escape early-fall freezes. The immature heads, however, may be used for salads.

Citron

Citron, used for preserves and pickles, is of minor importance in northern Great Plains gardens. The culture is similar to that of watermelons. Production at Mandan was somewhat uncertain because of the damage by early-fall frost.

Cucumbers

Both slicing and pickling cucumbers are popular in home gardens and are well adapted for planting in the northern Great Plains.

Planting in the garden is done from about May 10 to 15, after the ground has warmed up and danger of severe frosts is past. Six or eight seeds are planted to a hill, and later the plants are thinned to three. The hills are about 4 by 6 feet apart. In row planting the rows are spaced about 6 feet apart and the plants thinned to 1 or 2 feet in the row. Cucumbers are harvested when they reach the proper size; the slicing varieties grow larger than pickling varieties. The striped cucumber beetle was the most troublesome insect pest. Diseases caused but little damage.

Only summer squashes outranked the cucumbers in average yield on an acre basis, and the value of the produce was second only to tomatoes (table 3). Fordhook Famous, a slicing variety, was grown in all but 1 of the 26 years. Although its yield was below the average

for 15 of 25 years and the coefficient of variation is a little high (90 percent), the crop was fairly dependable (table 4). The extremely large yield in 1923 increased disproportionately the number of years below the mean and the coefficient of variation. Failures were recorded in 3 years.

Dill

The small branches and seed of dill are used for flavoring dill pickles, and the green leaves have value for flavoring soups and stews. This herb, planted in early spring for the leaves and in late May for flavoring pickles, is easily grown.

Eggplant

Eggplant is not widely grown in northern Great Plains gardens, but if properly cooked is popular with many people.

This is a warm-weather plant requiring a long season. Plants are therefore started indoors after the middle of March in seed flats, and the young seedlings are transplanted to other seed flats where they are spaced 2 or 3 inches apart. Potted plants have the advantage of not being set back so much when transferred to the garden in late May or early June. Rows should be about 3 feet apart and the plants spaced 1½ to 2 feet apart in the row. The fruits are harvested when they reach proper size and are well colored. Early-maturing varieties should be chosen, since damage often results from early-fall frosts. Flea beetles, blister beetles, and the Colorado potato beetle attacked this vegetable. Fruit rot caused damage in some years.

The variety Black Beauty was grown in the acre garden from 1923 to 1945, inclusive except for 1942, when the plants damped-off in the greenhouse and none were planted in the garden. The average yield for the period was only 27.7 pounds to 100 feet of row. Yields were below this average for 16 of the 22 years, including 7 years when the crop failed. The coefficient of variation (146 percent) is higher than for any other crop tested (table 4). Accordingly it would appear that this crop is not so well adapted for planting in northern Great Plains gardens as most of the other vegetables tested.

Endive

Endive, which is used as a salad plant, is grown like leaf lettuce. Plantings are made in early spring for summer use and in late July for fall use. This vegetable sometimes develops a strong flavor in hot weather when grown under dry-land conditions. Yields were satisfactory at Mandan.

Horseradish

Horseradish is grown in that part of the garden reserved for perennials or in any odd space that may be available. The root of this vegetable grated in white-wine vinegar or in distilled vinegar is used as a relish.

Cuttings of the side roots, taken at the time of fall digging, are used for propagation purposes. They are planted in rows about 3 feet apart and spaced 15 to 18 inches in the row. Some harvesting can be

done as needed after the roots become large enough to use, but horseradish makes its best growth and attains a better flavor in the cool weather of fall. The bulk of the crop is therefore dug in late fall just before the ground freezes. The roots are stored in sand in a cool root cellar and can be used as needed during the winter. Flea beetles were the most troublesome insect pest. This crop is well adapted for planting in northern Great Plains gardens. Production was reliable from year to year, and yields were satisfactory.

Kale, or Borecole

Kale, or borecole, is not so useful in northern Great Plains gardens as in regions where it can be depended on to survive the winter and furnish greens for winter and early-spring use. It usually makes good growth before being killed by winter freezes.

Successional plantings of this crop may be made, starting in early spring as soon as the ground can be worked. The plants should be thinned to stand about 4 inches apart in the row.

Kohlrabi

Kohlrabi, grown for its short fleshy stem produced just above the ground, has a delicate flavor somewhat between turnips and cauliflower. It is not so commonly grown in home gardens as many other vegetables, but it appears to be well adapted for planting in the northern Great Plains.

This vegetable may be sown in early spring in rows about 3 feet apart if machine cultivation is used. The plants are thinned to stand 6 to 8 inches apart in the row. They are harvested when the stems are 2 to 3 inches in diameter, since they become woody if left too long. The average annual yield at Mandan for the 4 years in which data were taken was 51 pounds to 100 feet of row. No failures were recorded, but this crop was not planted in the drought years 1934 and 1936.

Lettuce

Well adapted for planting in the northern Great Plains, lettuce should have a place in all home gardens. Both leaf lettuce and head lettuce are grown, the former more often than the latter since it generally produces a satisfactory crop whereas head lettuce sometimes bolts and goes to seed before many good heads are formed. This was especially noticeable in hot, dry summers. Irrigation is desirable for best results with lettuce.

The seed may be planted as early in the spring as the ground can be worked. The rows are spaced 3 feet apart for machine cultivation and about half that distance for hand working. Plants of leaf lettuce are thinned to stand 3 to 4 inches apart in the row and those of head lettuce about 8 inches apart. Better results are obtained with head lettuce if the plants are started indoors in the early part of April and set in the garden about May 10 to 15.

Melons

Both muskmelons and watermelons are grown to a considerable extent in home gardens of the area, success largely depending on the

choice of early-maturing varieties. They are prized for their palatability.

Planting is done in hills when the ground warms up and the danger of late-spring frosts is past, generally about May 10 to 15. Six or eight seeds are planted to a hill and the plants are thinned to three. The hills of muskmelons should be about 4 by 6 feet apart and watermelons about 8 by 9. If row planting is used muskmelon rows are spaced about 6 feet apart and plants thinned to 1 or 2 feet apart in the row. Watermelon rows should be 9 or 10 feet apart and the plants thinned to 3 or 4 feet apart in the row. Insects and diseases were not troublesome, although the striped cucumber beetle and flea beetles were evident in some years.

The variety of muskmelons grown in the acre garden was Emerald Gem, which had an average yield for the 25 years recorded of 28.1 pounds to 10 hills, or a rate of 5,100.2 pounds to the acre (table 3). Yields varied greatly from year to year as shown by the high coefficient of variation (127 percent), and 4 failures for the crop were recorded. This crop yielded below average 17 times as compared with 8 above (table 4). Muskmelons apparently are not so well adapted for growing in the northern Great Plains as are many other vegetable crops.

Watermelons also showed marked variation in yield from year to year as indicated by the high coefficient of variation (120 percent). They yielded below the average 14 times as compared with 10 above (table 4). The average yield for the variety Fordhook Early was 98.8 pounds for 10 hills, or a rate of 5,977.4 pounds to the acre (table 3). Hail, early-fall frosts, and hungry boys all wrought damage to this crop in some years, the last-named reducing the average yield considerably below that given.

Somewhat better results than those reported in these tests may be expected for both muskmelons and watermelons if the earliest and best varieties are chosen.

Mustard

Although mustard is seldom grown in northern Great Plains gardens, several varieties have been developed that are suitable for greens in this area if used before the leaves become too strong under the influence of hot, dry weather. Successional plantings may be made, starting in early spring, or plantings may be made in July for fall use. The plants should be thinned to stand about 5 inches apart in the row.

Onions

Onions are widely planted in home gardens. They are extensively used raw, cooked, and as a flavoring for other foods. Early-maturing varieties should be chosen and the seed planted in early spring as soon as the ground is ready. Rows should be about 18 inches apart and the plants thinned to about 2 inches apart in the row. The close spacing tends to produce medium-sized bulbs that are preferable to larger ones that may not mature before harvest. As a general rule, onions have been ready to harvest in the middle of September or a little later, when most of the tops cease to grow, bend down, and turn brown. After being pulled, the bulbs should be thoroughly dried in the sun or under cover depending on weather conditions, and then all mature bulbs

stored in a cool, dry place. Immature bulbs with green tops may be reserved for immediate use. Insects and diseases were not troublesome at Mandan.

Perennial onions, which are sometimes grown to furnish green onions in early spring, should be planted with the perennial crops, such as asparagus and rhubarb. They were hardy and productive at Mandan.

Onions, as represented by the varieties Southport Yellow Globe and Australian Brown, ranked near the middle, as compared with other vegetable crops, in both average yield and value on an acre basis. The average yield for the 25 years for which the yield data was kept was 35.6 pounds to 100 feet of row, or 10,338.2 pounds on an acre basis (table 3). Onions failed but twice during the 25 years, both failures being due to drought. Although yields below the average occurred 15 times as compared with 10 times above, the coefficient of variation (67 percent) indicates more consistency in production from year to year than in the case of many other crops (fig. 3). A consideration of all data indicates that onions are well adapted for planting in northern Great Plains gardens.

Orach

Orach is seldom grown in northern Great Plains gardens. Preliminary tests at Mandan indicate that it thrives as a greens crop and should be especially valuable where spinach fails to produce satisfactorily. Some prefer orach greens to spinach greens, because of their flavor and their smaller loss in weight in cooking. Orach is drought-resistant and grows vigorously.

The seed may be planted in rows about 3 feet apart as soon as the ground can be worked in the spring. The plants are thinned to about 3 feet apart in the row when they reach a height of 4 to 6 inches and the young plants including stems are used for greens. The remaining plants are allowed to grow, furnishing young, tender leaves for greens throughout the summer and seed in the fall.

Parsley

Both the foliage type of parsley, used for garnishing and as a flavoring for soups and stews, and the turnip-rooted form, used for its edible roots, occasionally are grown in northern Great Plains gardens. They may be planted as early in the spring as the ground permits, and later the foliage type may be thinned to 5 or 6 inches apart in the row and the turnip-rooted form to 3 or 4 inches. Fair to good yields were obtained at Mandan. The root form may be stored for winter use in sand in a root cellar in a manner similar to carrots.

Parsnips

Parsnips are not so popular as many other vegetables in home gardens. This vegetable requires a long growing season and may be planted when the ground is ready in early spring. Rows should be spaced 3 feet apart for horse cultivation and the young plants thinned to 2 or 3 inches apart in the row. Since frost improves the quality of parsnips, digging is postponed until late in the fall before the ground freezes. They may be buried outside in well-drained soil or

stored in sand in a root cellar for winter and early-spring use. Insects and diseases were not troublesome at Mandan.

The average yield of parsnips (Guernsey) for the entire period was 71.2 pounds to 100 feet of row, or 10,338.2 pounds on an acre basis (table 3). They failed 3 times during the period, twice because of drought and once because of poor germination. Yields were above the average 13 times as compared with 12 times below. The coefficient of variation (67 percent), which is lower than that of many other crops, indicates fairly consistent yields from year to year (table 4). On the whole, parsnips appear to be well adapted to the area.

Peas

Peas are one of the standard crops grown in most home gardens. Varieties are classed as smooth- or wrinkled-seeded; the former is more hardy as a general rule and germinates better in a cold, damp soil. Wrinkled-seeded varieties for the most part are sweeter and of better quality and may be planted almost as early as the smooth-seeded varieties in most years. Moderate-growing or dwarf varieties are more frequently grown, since the tall varieties require some support for best results. Peas are a cool-weather crop, and early planting in rows 3 feet apart is desirable. The season of use may be extended by planting early varieties at intervals of a week or 10 days or by planting at an early date varieties that mature at different times, the latter method being preferred by many growers. Successional plantings should not be continued into June as peas do not thrive in the hot, dry weather of summer. Insects and diseases were not troublesome at Mandan.

The average yield for all peas grown during the 25-year period was 15.6 quarts to 100 feet of row, or 2,265.1 quarts on an acre basis; the value on an acre basis was a little low as compared with the values of many other vegetables (table 3). Yields ran above the average more often than below, and a general failure was recorded but once. The coefficient of variation (60 percent) indicates more reliable yields from year to year than for most other garden crops (fig. 3).

The varieties Alaska and the early planting of Nott's Excelsior may be compared for 1920–43 except for 1929 when data were lost, or for 23 years (table 6). Average yields for Alaska were 17.0 quarts to 100 feet of row and for Nott's Excelsior 14.9 quarts. The former variety yielded more in 11 of the 23 years and Nott's Excelsior more in 10, they were equal in 1 year, and both failed in the drought year 1936. The difference in yield between the two varieties is not significant.

The early and late plantings of Nott's Excelsior, seeded on the average dates May 8 and May 29, respectively, may be compared for the period 1921–43 exclusive of 1929 and 1931, or for 21 years (table 6). The average yield of the early planting was 15.5 quarts to 100 feet of row and of the late 11.7 quarts. Yields from the early planting were greater than from the late in 14 of the 21 years and less in 5; the yields of both were equal in 1 year and failed in 1. The yields of the early planting were significantly better than those of the late.

Early and late plantings of Little Marvel can be compared for 2 years, 1944 and 1945, the average yield being 30.2 quarts to 100 feet of row for the early planting and 20.0 quarts for the late.

Although not ranking high in average yields or value on an acre basis in comparison with other vegetables, peas were consistent pro-

ducers and are one of the most popular vegetables. Their inclusion in northern Great Plains gardens is well justified.

Peppers

Although not one of the most important crops in home gardens, mild sweet peppers are often grown and used as baked stuffed peppers, for flavoring, or in salads or pickles.

Peppers are grown in hotbeds or greenhouses and transplanted to the garden in late May or early June, after all danger of severe frosts is past. Potted plants are preferable to those grown in seed flats. The pepper plants are set in rows about 3 feet apart and spaced 1½ to 2 feet in the row. Early-maturing varieties should be grown, since damage often occurs from early-fall frosts. Insects and diseases caused but little damage at Mandan.

The average yield of peppers (Ruby King) for 1924–45, except for 1929 and 1937 when data were lost, was 11.8 pounds to 100 feet of row, or 1,713.4 pounds on an acre basis (table 3). Except for shell beans, peppers gave the lowest average yield of any of the crops grown and the value on an acre basis was lower than that of most other vegetable crops. During the 20 years for which data are available, peppers yielded below average 12 times and failed 7 times. The coefficient of variation (89 percent) indicates more variability in yields from year to year than for most other vegetables (table 4).

Peppers do not appear to be very well adapted for growing in northern Great Plains gardens, but this should not discourage those who have a special liking for sweet peppers. Hot peppers, as a rule, do not mature early enough to escape early-fall frost.

Potatoes

Potatoes are grown in most northern Great Plains gardens. Often a piece of ground separate from the regular garden is used to produce them in quantities for storage or sale.

Potatoes are frequently allowed to sprout in the greenhouse or a warmer place than the regular storage bin for a few weeks before planting, in order to produce a crop for table use in late July and August. These sprouted tubers may be cut into blocky seed pieces about 1½ ounces in weight and planted about May 1, care being taken not to break off the sprouts. The main crop usually is planted about May 10 in rows 3 to 3½ feet apart, the tubers spaced 15 to 18 inches apart in the row. Early-maturing or midseason varieties should be chosen, because late varieties may be damaged by early-fall freezes before they mature. Harvesting should take place in late September or early October and the tubers allowed to dry in the sun or elsewhere before being stored in the root cellar for winter use.

Since many different diseases and insects attack potatoes, it is important that the grower plant disease-free seed and be prepared to spray or dust when necessary. Flea beetles, blister beetles, and the Colorado potato beetle were the most troublesome insect pests. The diseases were early blight, late blight, blackleg, common scab, rhizoctonia, canker, storage rots, and various virus diseases including spindle tuber and mosaic.

The average yield of Early Ohio potatoes for 1920–45 except for 1921 and 1929 was 52.3 pounds to 100 feet of row, or 126.6 bushels on an acre basis (table 6). Neither the average yield nor the average value of the produce was high in comparison with those of most other vegetable crops. The yields, however, were equally distributed above and below the average, with only one failure recorded for the 24-year period. The coefficient of variation (38 percent) is lower than that for any other annual vegetable (table 4). This indicates that potatoes were very consistent producers from year to year. Since several varieties of potatoes tend to outyield Early Ohio, higher yields than those obtained in the acre garden may be expected for this crop if the right varieties are chosen.

Pumpkins

Pumpkins are not so widely grown in farm gardens as many other vegetable crops, one objection being the amount of space taken up by the vines in the small garden, but they are popular for pies.

Planting should be done when the ground warms up and damage from late-spring frosts is past, usually May 10 to 15. Six to eight seeds are planted in a hill, and the hills are thinned to 3 or 4 plants. Hills should be spaced about 8 by 9 feet, except for such types as Cheyenne Bush, which require less room and may be spaced about 4 by 6 feet. Pumpkins may be planted also in rows spaced 9 or 10 feet apart and the plants thinned to 3 or 4 feet apart in the row. Bush types may be planted in rows 6 feet apart and the plants thinned to 1 or 2 feet apart in the row. Varieties should be chosen that mature early enough to escape early-fall frosts. Pumpkins may remain in the field until there is danger of heavy fall frosts, but the mature fruits should then be harvested. After they are put in a fairly warm dry place about 15 days for proper curing and hardening, they should be stored on shelves in a dry room at medium temperatures for winter use. The striped cucumber beetle and the squash bug caused damage at Mandan, but diseases were not troublesome.

Pumpkins, as represented by Small Sugar, had an average yield of 208.2 pounds for 10 hills, or 12,596.1 pounds on an acre basis (table 3). Failures were recorded only for the drought years 1934 and 1936. Yields were below the average in only 10 years of the 25-year period; the coefficient of variation (57 percent), which is low in comparison with the coefficients for most other vegetable crops, indicates reliable production from year to year (table 4).

Radishes

Radishes are grown in most home gardens. They do best in the cool weather of spring, going to seed quickly in hot summer months.

Two plantings are generally made, the first as soon as the ground can be worked in the spring and the second about 2 weeks later. Radishes are often grown as an early-maturing crop between wide-spaced rows of later maturing vegetables. Seed is often planted too thick, but if this occurs the young plants can be thinned to stand 1 or 2 inches apart in the row. Seed of winter radishes may be sown in July for fall use and winter storage and the plants thinned to stand 3 or 4

inches apart in the row. Flea beetles were the most troublesome insect pest.

Rhubarb

Rhubarb is well adapted for planting in the northern Great Plains and is useful in the early spring for pies and sauce. The leaves should *not* be used for greens.

It should be planted in that part of the garden reserved for perennials, where it will continue to produce for many years. One-year-old seedlings or divisions of the crown with strong eyes, or buds, are used for planting, which may be done in the fall but is more often done in the early spring. Rows should be about 5 feet apart and the plants spaced about 3 feet apart in the row. No harvesting should be done in the first year and very little in the second, but in later years leafstalks may be pulled for a period of about 2 months or until the first part of July. Too heavy pulling of stalks weakens the plants. Seedstalks should be removed when they appear. Manuring is desirable as rhubarb thrives best on a rich soil. No failures were recorded and production was reliable from year to year. A dozen plants should furnish sufficient rhubarb for the ordinary family.

Rutabagas and Turnips

Although not so popular as many other vegetables, rutabagas and turnips are often grown in northern Great Plains gardens. They sometimes develop a strong or bitter flavor under dry-land conditions. Turnips are of most value for greens and early-summer use, whereas rutabagas generally are preferred for the fall crop and winter storage.

Turnips should be planted in early April for greens and for summer use and in early July if a fall crop is desired. Rutabagas require a longer season and should be planted in the latter part of May for the fall crop. Rows may be 20 to 36 inches apart, depending on the type of cultivation, and the plants should be thinned to 5 or 6 inches apart in the row. They are harvested in late September or early October, before severe freezing, and stored in a cool root cellar in sand or in bins as for potatoes. Flea beetles were the most troublesome insect at Mandan, but diseases caused little damage.

Rutabagas (Golden Neckless) ranked high in average yields and in value on an acre basis (table 3). The average yield for the 25-year period was 90.1 pounds to 100 feet of row, or 13,082.5 pounds on an acre basis. The only failure recorded was due to the drought of 1936. Yields ranged about equally above and below the average; and the coefficient of variation (57 percent), low in comparison to the coefficients of most other crops, indicates that rutabagas were consistent producers from year to year (table 4).

Salsify, or Oysterplant

Salsify, or oysterplant, is of minor importance in home gardens. It is grown for its roots, which are cooked like carrots and parsnips or used for soups and stews.

Salsify may be seeded as early in the spring as the ground can be worked, and the plants may be thinned to 3 or 4 inches apart in the row. Harvesting is done in late fall, when the roots may be stored in sand in a cool root cellar for winter use. The average yield for 4 years at Mandan was 31 pounds to 100 feet of row. Roots of acceptable size were not produced in dry years.

Spinach and New Zealand Spinach

Spinach is the most common crop grown for greens in home gardens of the northern Great Plains.

It should be planted as early in the spring as the ground can be worked, since it does best in cool weather and tends to go to seed and become strong in flavor in the hot days of summer. The plants are thinned to stand 4 to 6 inches apart in the row, the larger plants being pulled out in thinning and used for greens.

New Zealand spinach is not botanically related to ordinary spinach, but it endures hot weather and furnishes greens throughout the summer and fall. It gave satisfactory and reliable production at Mandan.

Squashes

Squashes, like pumpkins, take up considerable room in the small garden, but are a more popular garden crop. This vegetable is divided into two classes: Summer squashes, such as Zucchini and Golden Crookneck, which are used before reaching full maturity, and winter squashes, such as Golden Hubbard, which are allowed to mature and can be stored for winter use.

The culture of squashes is practically the same as that described for pumpkins; the bush types like Cocozelle are planted in hills 4 by 6 feet apart and the more vigorous growers in hills 8 by 9 feet apart. In row culture, the rows may be 9 or 10 feet apart and the plants thinned to 3 or 4 feet apart in the row; for bush types the rows may be 6 feet apart and the plants thinned to 1 or 2 feet apart in the row. Winter squashes are harvested and stored as recommended for pumpkins. The striped cucumber beetle, flea beetles, and squash bug caused damage to squashes at Mandan, but diseases were not troublesome.

The average yield of summer squash (Cocozelle) for 1920–45, except for 1929, was 144.6 pounds for 10 hills, or 26,244.9 pounds on an acre basis. This is the highest average yield per acre recorded for any vegetable crop, and the value on an acre basis also ranks high (table 3). This yield may be a little high because some squashes were allowed to grow larger than they should for best quality. Failures were recorded for 1933, 1934, and 1936, and yields were below the average for 15 of the 25 years under test. The coefficient of variation (80 percent) indicates that the variation in yields from year to year was close to the middle as compared with the other vegetable crops (table 4).

Golden Hubbard was the winter squash grown, and its average yield for the 25 years for which records were kept was 201 pounds for 10 hills, or 12,160.5 pounds on an acre basis (table 3). This yield compares favorably with the yields of the majority of other vegetable crops tested but comes far short of the average acre yield recorded for

Cocozelle. Golden Hubbard squash failed to produce in 4 of the 25 years, but yields were above the average 12 times as compared to the 13 times below. The coefficient of variation (66 percent) indicates less variation in yield from year to year than for Cocozelle and most other vegetable crops (table 4).

On the whole, it appears that squashes are well adapted for planting in the northern Great Plains.

Sweet Corn

Sweet corn is one of the favorite vegetables grown in gardens of the northern Great Plains.

Early planting is not desirable as sweet corn is essentially a warm-weather crop. In order to extend the season for use, successional plantings of some early variety may be made at intervals from about May 5 to June 1, or varieties that ripen on different dates may be planted about May 10. Many growers prefer the latter method. Rows should be about 3 feet apart and the plants spaced about 20 inches apart in the row. Corn earworms caused damage at times, and smut was the most troublesome disease.

Sweet corn (Burpee's Golden Bantam) produced an average yield of 41 ears to 100 feet of row, or 5,953.2 ears on an acre basis for 1920–45 except for 1929 when data were lost (table 3). This yield is lower than for most other vegetable crops and the value of the product on an acre basis is also low. Some of the new hybrid sweet-corn varieties, however, produce higher yields on an average than the Golden Bantam.

Early and late plantings of Burpee's Golden Bantam sweet corn, made on the average dates May 8 and May 28, respectively, may be compared for the years 1921–45 exclusive of 1929 (table 6). Average yields favor the early plantings, which averaged 43.6 ears to 100 feet of row as compared with 40.9 ears for the late planting, but this difference is not significant. The early planting yielded more in 10 of the 24 years and the late in 9, they were even in 1, and both failed in 4. The late planting failed 5 years as compared with 4 for the early. For both plantings yields below the average occurred considerably more often than yields above the average, and the coefficients of variation (100 percent for the early planting and 86 percent for the late) indicate considerable variation in yields from year to year as compared with most other vegetable crops (table 4).

Swiss Chard

Swiss chard, which belongs to the same family as beets, thrives in the northern Great Plains, enduring hot, dry weather and producing excellent greens from early summer until killed by late-fall freezes. The large leaves are easily picked and the entire leaf may be used for boiling greens; or the large midribs of the leaf may be cooked like asparagus and the rest of the leaves cooked separately.

Swiss chard may be planted in early spring and the plants later thinned to about 8 inches apart in the row. Reliable production was the rule, and many consider this the most useful greens crop for planting in northern Great Plains gardens.

Tomatoes

Tomatoes are well adapted for growing in the northern Great Plains and are one of the favorite vegetables in home gardens. Since they are subject to frost damage and require a long season, they are started indoors. The seeds are sown in seed flats in the first part of April. About 1 week after germination the seedlings are transplanted to other seed flats where they are spaced about 2 inches apart. They are then kept in a warm place in the greenhouse, hotbed, or warm window until about May 1, when they are transplanted to coldframes and spaced about 4 by 6 inches apart. If only one transplanting is done, the plants are spaced about 4 inches apart in the second seed flat and the whole flat is placed in the coldframe about May 1. The sashes of the coldframe may be removed on warm days, but care should be taken to protect coldframes with blankets or other material during severe frosts. Individual plants may be potted and the pots placed in the coldframe. This method requires more labor but is advantageous because the roots are less damaged and the plants do not receive so great a setback when transplanted to the garden. Earlier tomatoes are often produced by this method.

Tomatoes are set out in the garden after danger of severe frosts is past, generally in the latter part of May or early June. Small-vined varieties that do not make a vigorous growth are planted in rows 3 to 3½ feet apart and spaced about 2½ feet apart in the row. More vigorous growing varieties should be planted in rows 4 feet apart and spaced 3 feet apart in the row. A starter solution at the time of transplanting to the garden was found to be beneficial.

Figure 4.—Pruned and staked tomatoes in the acre garden.

Staking tomatoes often results in earlier fruiting and heavier yields. The pruning of staked tomatoes is begun shortly after the plants are set out, the tomatoes being pruned to one stem and tied to the stakes. They are gone over every few days to remove the shoots starting in the axils of leaves when they are about 2 inches in length, and to keep the main stem tied close to the stake, just above the flower clusters, in order to furnish better support for the fruit (fig. 4). Blister beetles and the Colorado potato beetle caused some damage at Mandan, and blossom-end rot, septoria leaf spot, and other unidentified diseases were troublesome in some years.

Sunnybrook Earliana tomatoes were grown in the acre garden, and the plants were staked. The average yield for the 25 years for which records were kept was 110.3 pounds to 100 feet of row, or 16,015.6 pounds on an acre basis. Thus tomatoes rank third in average yield among vegetables tested and first in average value on an acre basis (table 3). Only 1 failure was recorded for 1920–45 except for 1929, when data were lost. Yields were below the average 14 times as compared with 11 times above (table 4). The coefficient of variation (40 percent) is lower than for any other annual vegetable except potatoes and indicates less variation in yields from year to year than for most other vegetables. Tomatoes are one of the most important vegetable crops in the northern Great Plains.

SUGGESTIONS FOR GARDENING IN THE NORTHERN GREAT PLAINS

Selection of Site

A site near the farm building is desirable for convenience in caring for the garden and harvesting the crops. Most soils that are suitable for general farming are suitable for gardens. However, it is well to avoid extremely heavy soils, which are difficult to manage, and very light sandy soils, which may suffer more from drought. Alkaline soils and those that are very rocky should be avoided. Fairly level land should be chosen since it is in less danger from erosion by heavy rains. If sloping land is used the rows should be planted so that the crops can be cultivated across the slope rather than up and down it. The area chosen should be large enough for wide spacing and machine cultivation and for the production of enough vegetables in years when yields are low because of drought or other factors.

The area of the garden will vary on different farms according to the size of the family to be fed, the richness of the soil, the time the farmer or his family have for gardening, the facilities for disposing of surplus products, and the availability of irrigation water. The last is an insurance against low yields in dry years and makes a much smaller garden practicable. The 1-acre dry-land garden at Mandan produced on an average over 6,600 pounds of vegetables in a year, or a weekly average of about 127 pounds. This is probably three to five times the quantity of vegetables needed by the ordinary family of five. Accordingly each farmer should adjust the size of his garden to his own needs, remembering that production in any one year is just as likely to be below average as above.

Protection From Wind

Protection from wind is important, especially on the south, west, and north sides of the garden. Such protection aids in preventing drying out, mechanical damage, and soil blowing and assists in the collection of snow on the garden site during the winter. If natural protection is not available, a single row of Siberian pea-trees or Russian-olives planted about 4 feet apart on the sides most exposed will afford much protection. A three-row windbreak is better and may consist of Siberian pea-tree on the outside, Chinese or American elm in the center, and Russian-olive or chokecherry in the inside row next to the garden. The rows should be about 10 feet apart and the trees spaced 6 feet apart in the row, except for the outside row of Siberian pea-tree in which the trees should be about 4 feet apart.

Preparation of Soil

Plowing may be done in early spring but late-fall plowing is considered best, since it helps in destroying insect eggs and larvae, gives the soil time to settle, and produces a more compact seedbed for early-spring planting. Thorough harrowing before planting breaks up lumps and produces the smooth surface suitable for the planting of small garden seed. An additional smoothing with some kind of float or planker may be useful on soils that do not have a tendency to blow. Larger vegetable seeds, potatoes, and transplants do not require so smooth a surface as small seeds do.

Fertilizers

Animal manures usually are used as fertilizers for northern Great Plains gardens. The manure should be well rotted and spread as evenly over the surface as possible before being plowed under or thoroughly disked into the soil. Besides supplying necessary plant elements the manure furnishes humus, which is important in improving the texture of certain soils.

Commercial fertilizers are seldom used in the area, but if manure is not available they may be used to advantage on many gardens. The quantity and composition of the commercial fertilizer needed will depend on the soil, but 2 or 3 pounds of a well-balanced fertilizer (4–12–4) to 100 square feet of garden area should be sufficient for most gardens. Care should be used in applying commercial fertilizers as too much may cause burning of crops under dry-land conditions. The commercial fertilizer may be broadcast before planting and worked into the soil, or bands of it may be applied on both sides of a row of vegetables at planting time or early in the season of growth, the fertilizer being placed about 4 inches below the surface of the ground and 2 or 3 inches from the sides of the row. The latter method is believed to be more efficient in that it gives better results for the same amount of fertilizer. If different types of fertilizer are used, leaf crops respond best to those having a high nitrogen content, whereas vine and root crops require more phosphorus and potash. As most of the soils of the area have enough potash, this element is not so important in commercial fertilizers for northern Great Plains gardens.

If manure is not available, commercial fertilizers should be supplemented by compost piles to keep up the humus supply. A compost pile is made with alternate layers of soil and manure, leaves, straw, grass, immature weeds, or other organic material. This pile should be made a year or two in advance and should be forked over several times during the course of decomposition.

Recommended Varieties and Planting Schedule

Considerable disagreement exists as to the best varieties of vegetables for planting in the northern Great Plains. The varieties listed in table 7 are suggested because they have done well at Mandan or in much of the northern Great Plains, but many varieties not mentioned have merit and may excel in certain sections. Furthermore, better varieties, especially hybrids of some vegetables that tend to outyield old standard varieties, are being introduced from time to time.

The planting schedule given in table 7 should be varied somewhat from year to year, planting being done earlier in early seasons than in late seasons. Some plants that require a long season, such as tomatoes, eggplant, peppers, cabbage, cauliflower, head lettuce, broccoli, and celery, should be started indoors. Seed is planted in March or April and the plants are set out in the garden after danger of damage from late-spring frosts is past. Of the vegetables seeded directly in the garden, some are slow to germinate or can stand light frosts and may be seeded as soon as the ground can be worked in the spring. Examples are onions, radishes, parsnips, carrots, leaf lettuce, spinach, and early smooth-seeded peas. Others, such as beans, squashes, pumpkins, cucumbers, and melons, are easily damaged by frost, and seeding should not take place until the ground warms up and most of the frost danger is past. Planting of most vegetables grown for winter storage is delayed in order to grow a product of better quality, since early planting often results in large, coarse vegetables below par in flavor. Examples are rutabagas, carrots, turnips, and beets.

Table 7.—*Recommended varieties and planting schedule of vegetable crops for northern Great Plains*

Crop and season	Recommended varieties	Recommended planting date or period		Harvest
		Indoors	Outdoors	
Asparagus	Mary Washington; Paradise		April	
Beans:				
Pole	Kentucky Wonder; McCaslan; Decatur.		May 12–18	
Shell	Great Northern; Hidatsa Red		do	
Snap or bush	Stringless Green Pod; Bountiful; Tendergreen; Pencil Pod Black Wax; Sure Crop Wax; Improved Golden Wax (Top Notch strain).		May 7–10 May 25–28	Early. Late.
Beets	Detroit Dark Red; Ohio Canner; Crosby Egyptian; Red Ball.		May 1–5 May 25–28	Early. Late.
Broccoli	Italian Green Sprouting	Mar. 20–Apr. 1	May 10–15	
Cabbage:				
Early	Golden Acre; Early Jersey Wakefield.	do	do	Early.
Midseason	Copenhagen Market	Mar. 25–Apr. 10	May 15–20	Midseason
Late	Danish Ballhead; Penn State Ballhead.	Apr. 5–20	May 20–June 1	Late.

TABLE 7.—*Recommended varieties and planting schedule of vegetable crops for northern Great Plains*—Continued

Crop and season	Recommended varieties	Recommended planting date or period		Harvest
		Indoors	Outdoors	
Carrots	Nantes (Coreless); Chantenay; Danvers Half Long; Tendersweet.		Apr. 14–20 May 25–28	Early. Fall.
Cauliflower	Snowball; Erfurt; Snowdrift; Dry Weather.	Mar. 20–Apr. 1 Apr. 5–20	May 10–15 May 20–June 1	Early. Late.
Celery	Golden Plume; Giant Pascal; Golden Self Blanching.	Mar. 15–Apr. 1	do	
Swiss chard	Fordhook Giant; Lucullus		Apr. 14–May 1	
Chinese cabbage	Chihli; Michihli; Wong Bok		June 20–July 1	
Sweet corn	Golden Bantam (Great Plains strain); Golden Cross Bantam; Spancross; Marcross; Lincoln.		May 5–10 May 20–June 1	Early. Late.
Cucumbers:				
Slicing	Straight Eight; Early Fortune; Black Diamond; Burpee Hybrid.		May 10–15	
Pickling	National Pickling; Chicago Pickling.		do	
Eggplant	Black Beauty; New Hampshire	Mar. 15–Apr. 1	May 28–June 4	
Endive	Green Curled; Deep Heart; Broad Leaved Batavian.		Apr. 14 July 20–Aug. 1	Spring crop. Fall crop.
Kale	Green Curled Scotch; Dwarf Siberian.		Apr. 14–June 1	
Kohlrabi	Early White Vienna; Early Purple Vienna.		Apr. 14–May 1	
Lettuce:				
Leaf	Early Curled Simpson; Grand Rapids; Slobolt; Black-Seeded Simpson.		Apr. 14–20	
Head	New York 515; Improved Hanson; Great Lakes; Imperial 44.	Apr. 1–10	May 10–15	
Melons:				
Muskmelons	Honey Rock; Hale's Best; Lake Champlain; Bender's Surprise.		do	
Watermelons	Cole's Early; Golden Honey; Dakota Sweet; Ice Box; Arikara.		do	
Mustard	Florida Broad Leaf; Southern Giant Curled.		Apr. 14–June 1 July 1–Aug. 1	Early crop. Fall crop.
Onions:				
Seed	Southport Yellow Globe; Prizetaker; Yellow Globe Danvers; Red Wethersfield.		Apr. 14–20	
Plants	Sweet Spanish	Mar. 10–15	May 10–15	
Parsnips	Guernsey (Hollow Crown); Short Thick.		Apr. 14–20	
Peas	Alaska; Little Marvel; Laxton Progress; Lincoln.		do May 1–5 May 25–28	Early smooth. Early wrinkled. Late.
Peppers:				
Bell	Merrimac Wonder; King of the North; California Wonder.	Mar. 15–Apr. 1	May 28–June 4	
Pimento	Sunnybrook; Burpee's Early Pimento.	do	do	
Potatoes	Warba; Irish Cobbler; Triumph; Chippewa; Pontiac.		May 1–15	
Pumpkins	Small Sugar; Early Cheyenne; Cheyenne Bush; Omaha.		May 10–15	
Radishes:				
Spring	Sparkler; Saxa; Burpee White; White Icicle.		Apr. 14–30	
Winter	China Rose Winter; Long Black Spanish.		July 15–Aug. 1	
Rhubarb	Chipman's Canada Red; Valentine; McDonald.		Early spring or fall.	
Rutabagas	Improved American Purple Top Yellow; Golden Neckless.		May 25–28	Fall crop.
Spinach	Long Standing Bloomsdale; King of Denmark.		Apr. 14–20	
Spinach (New Zealand).			Apr. 14–30	

TABLE 7.—*Recommended varieties and planting schedule of vegetable crops for northern Great Plains*—Continued

Crop and season	Recommended varieties	Recommended planting date or period		Harvest
		Indoors	Outdoors	
Squashes:				
Summer	Zucchini; Cocozelle; Early White Bush; Summer Crookneck.		May 10–15	
Winter	Golden Hubbard; Buttercup; Acorn (Table Queen); Will's Banquet.		do	
Tomatoes	Victor; Bounty; Firesteel; Orange King; Earliana (Mandan or Sunnybrook strain); Sioux; Pritchard; Chatham.	Apr. 1–15	May 28–June 4	
Turnips	Extra Early White Milan; Purple Top White Globe; Golden Ball.		April July 1	Early. Fall.

CONTROL OF DISEASES AND INSECTS [7]

Diseases and insects were not unduly troublesome in the acre garden, but it is important that the grower be prepared to use effective measures for their control. A small garden sprayer with a capacity of 3 to 10 gallons or a good hand-operated duster with a capacity of 1 to 10 pounds should serve the needs of the home gardener.

Plant diseases are of two major types, nonparasitic and parasitic. Nonparasitic diseases are caused by unfavorable conditions in the environment of the plant, such as lack or excess of some mineral elements in the soil, extremes of temperature, and drought or excessive moisture. Parasitic diseases are caused by organisms such as fungi and bacteria and by plant viruses. They are the most common cause of disease losses on vegetable crops.

The control of parasitic diseases is based on preventing these diseases and their spread, since ordinarily it is not possible to cure diseased plants. Because some organisms causing diseases in plants may be carried on or in the seed, efforts should be made to obtain disease-free seed. Simple chemical treatments will help prevent the seed decay and the killing of germinating seeds and seedlings caused by damping-off fungi in the soil. Certain treatments also will destroy disease-producing organisms carried on the seed. Some fungi and bacteria can live over winter in the soil, and therefore clean soil should be used for growing seedling plants for transplanting. It is not advisable to grow the same crop in the same place in the garden each year. Since perennial weeds may carry some viruses that attack cucumbers, tomatoes, and certain other vegetables, it is important to destroy all weeds near the garden. A number of the most common viruses attacking vegetable crops are spread by aphids that have fed on diseased plants; in this way such diseases are transmitted from weeds to cultivated

[7] For more detailed information on the control of insects and diseases, see: WHITE, W. H., and DOOLITTLE, S. P. A VEGETABLE GARDENER'S HANDBOOK ON INSECTS AND DISEASES. U. S. Dept. Agr. Misc. Pub. 605, 30 pp., illus. 1946; and MUNRO, J. A. INSECT PESTS OF TREES AND GARDENS. N. Dak. Agr. Col. Ext. Serv. Spec. Cir., 64 pp., illus. 1939.

plants. Certain bacterial diseases are also spread by insects, and insect control is of importance in checking them.

The use of fungicides as sprays or dusts can be effective in controlling many vegetable diseases. It is important, however, that the fungicide be applied before the disease has caused extensive damage. Unless the plant is well covered with a light, even coating of the material, the results are not likely to be satisfactory. When rains are frequent, more applications are needed than during long periods of dry weather. Copper fungicides are generally used for control of diseases on vegetable crops. In the past, bordeaux mixture, a very effective fungicide, was generally used. It has been found, however, that it may be somewhat injurious to certain crops, particularly cucumbers, melons, and tomatoes. For this reason the so-called fixed copper fungicides have come into rather general use on these and a number of other vegetable crops. These latter materials, such as tribasic copper sulfate, copper oxychloride, copper oxychloride sulfate, and cuprous oxide, have given effective control of many diseases.

Many of the common insects [8] attacking vegetables, such as flea beetles, Colorado potato beetle, cabbage caterpillars,[9] cucumber beetles, and some species of blister beetles and aphids can be controlled with dusts or sprays containing rotenone. This insecticide can be used with safety on all garden crops because at strengths sufficient to kill insects it is not poisonous to human beings or to animals or birds. Webworms, leafhoppers, the tarnished plant bug and related species, and cabbage caterpillars can be controlled with dusts or sprays containing pyrethrum. This material also is nonpoisonous and can be used with safety on all garden crops. Aphids and onion thrips can be controlled with nicotine dust or spray, which is usually sold in the form of nicotine sulfate. It is nonpoisonous at strengths used for insect control.

Blister beetles are difficult to control with insecticides, but cryolite or sodium fluosilicate and DDT are fairly effective against these pests. In small gardens they may be jarred or shaken into a shallow receptacle containing kerosene where they quickly die. Gloves should be worn if the beetles are handled, as the beetles may cause blisters on the hands.

Squash bug also is difficult to control, but a new insecticide known as sabadilla is effective against it. Some relief from it may be obtained by dusting or spraying the young bugs with nicotine, pyrethrum, or rotenone.

Root maggots attacking cabbages, turnips, radishes, and related crops can be controlled by treating the base of the plants and the adjacent soil with either calomel or corrosive sublimate.

For the control of cutworms a poisoned bran bait should be used before planting the vegetable garden or should be scattered lightly on the soil at the base of the plants if later infestations develop. For the control of grasshoppers a poisoned bran bait scattered thinly over

[8] Material on control of insects was furnished by Division of Truck Crop and Garden Insect Investigations, Bureau of Entomology and Plant Quarantine, Agricultural Research Administration.

[9] Green caterpillars on cabbage, cauliflower, broccoli, brussels sprouts, kale, kohlrabi, and related crops.

the soil around, but not on, the growing plants may be used. The formula for the poisoned bait is as follows:

Sodium fluosilicate or paris green	¼ pound.
Dry, flaky wheat bran	5 pounds (1 peck).
Water to moisten	3 or 4 quarts.

Mix thoroughly the poison and the dry bran. Then moisten the mixture with water until each flake of the bran has been wetted.

For corn earworm control one-quarter teaspoonful of medicinal mineral oil should be injected into the base of the silk mass with an oilcan or a medicine dropper as soon as the silks have become wilted. This wilting occurs usually on about the fourth day after the silks appear. Some insecticide companies can supply oil with an insecticide added for more effective corn earworm control and special force oilers for more rapid application.

The new insecticide DDT is an effective all-purpose insecticide for use as a dust or spray on potatoes for the control of several insects commonly attacking that crop, including the Colorado potato beetle, flea beetles, leafhoppers, and blister beetles. It is also effective against cabbage caterpillars, onion thrips, and the tarnished plant bug and related species, as well as some species of aphids. Although not injurious to most garden crops so far as known at present, this insecticide in some forms may injure some varieties of summer squashes, pumpkins, and cucumbers. DDT is available in several formulations of dusts and sprays. Directions on the label of the package in which the material is sold should be followed carefully. Recently a highly purified form not injurious to the cucurbits mentioned has been developed.

Paris green and calcium arsenate are useful in the control of some leaf-eating insects, such as the Colorado potato beetle, cabbage caterpillars, cucumber beetles, flea beetles, and blister beetles. Bordeaux mixture, used commonly as a fungicide, acts as a repellant for leafhoppers and flea beetles.

During dusting or spraying every effort should be made to apply a light, even coating on the entire plant. Unnecessarily heavy applications should be avoided. Large insects, such as hornworms on tomatoes and peppers and caterpillars on carrots, parsnips, and parsley, can be controlled to best advantage by hand-picking when only a relatively few plants are infested.

Information regarding the purchase of insecticides and fungicides may be obtained from experienced local gardeners, local dealers in agricultural supplies, or seedsmen; or through the county agricultural agent, State agricultural college, State department of agriculture extension service, or the United States Department of Agriculture.

Unless the poison residues can and will be removed by washing or stripping, do not apply to plants any dust, spray, solution, or bait that contains such materials as paris green, calcium arsenate, cryolite, sodium fluosilicate, calomel, corrosive sublimate, or DDT, when foliage or fruit that is intended to be eaten is on the plants.

In handling, mixing, and applying poisonous insecticides and fungicides, take special care not to inhale excessive quantities at any time. After working with such chemicals wash the hands or any exposed parts of the body thoroughly.

Containers in which these materials are kept or stored should be plainly labeled and placed under lock and key or at least out of the reach of irresponsible persons or children. Any unused portions of these poisonous preparations as well as the receptacles in which they have been mixed should be treated likewise.

Equipment

The equipment required for successful gardening should include a one-horse cultivator, preferably with seven or nine shovels, or a garden tractor, hoes, rakes, a sprayer or duster, trowel, steel dibble, garden planter, and a hotbed (6 by 12 feet) with four standard hotbed sashes (3 by 6 feet). A root cellar is desirable for winter storage.

REQUIREMENTS FOR SUCCESSFUL GARDENING

Productive gardens for home use are very desirable in the northern Great Plains, where more vegetables are often needed for a healthful and varied diet. Although some climatic factors are adverse and failures may occur in rare drought years in the absence of irrigation, yield data for a 26-year period indicate that many vegetables produce satisfactory crops in most years and give a good return for the money and efforts expended. Some of the more important requirements for successful gardening in this area may be summarized as follows:

1. Selection of a comparatively level site of adequate size, protected from wind and having good soil.
2. Use of a planting plan so that sufficient plants and seed may be provided.
3. Following a rotation system for the better control of insects and diseases and for the application of manure to crops that will derive the greatest benefit therefrom.
4. A thorough preparation of the soil by fall plowing and early-spring harrowing.
5. Emphasis on crops that show good yields and reliable production over a long period rather than on those that show wide fluctuation in yields from year to year and often fail.
6. Use of standard varieties recommended for the area by Federal or State experiment stations or of those known to do well in a particular section and the planting of each vegetable at the proper time as recommended in planting schedules.
7. Use of wide spacing and machine cultivation to control weeds, conserve moisture, and save labor.
8. Early thinning of the different vegetables according to their space requirements.
9. Control of insect pests and diseases before serious damage is done.

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